Mitigation Plan
Hornpipe Branch Tributaries
Mitigation Project

Lenoir County, North Carolina

FINAL VERSION

NCDEQ DMS Project Identification # 100076
NCDEQ DMS Contract # 7605
Neuse River Basin (Cataloging Unit 03020202)
USACE Action ID Number: SAW-2018-01762
DWR Project #20-0048
Contracted Under RFP # 16-007401

Prepared for:

Environmental Quality

North Carolina Department of Environmental Quality
Division of Mitigation Services
1652 Mail Service Center
Raleigh, NC 27699-1652

AUGUST 2020

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August 24, 2020

US Army Corps of Engineers
Regulatory Division, Wilmington District
Attn: Kim Browning
3331 Heritage Trade Drive, Suite 105
Wake Forest, NC 27587

RE: WLS Responses to NCIRT 30-day Review Comments Regarding Task 3 Submittal, Final Mitigation Plan Approval for the Hornpipe Branch Tributaries Mitigation Project, USACE AID# SAW-2018-01762, NCDEQ DMS Full-Delivery Project ID #100076, Contract #7605, Neuse River Basin, Cataloging Unit 03020202, Johnston County, NC

Dear Ms. Browning:

Water & Land Solutions, LLC (WLS) is pleased to provide our written responses to the North Carolina Interagency Review Team (NCIRT) review comments dated June 16th, 2020 regarding the Final Draft Mitigation Plan for the Hornpipe Branch Tributaries Mitigation Project. We are providing our written responses to the NCIRT's review comments below, which includes editing and updating the Final Mitigation Plan and associated deliverables accordingly. Each of the NCIRT review comments is copied below in bold text, followed by the appropriate response from WLS in regular text:

DWR Comments, Mac Haupt:

1. DMS comments-DWR appreciates the review by DMS staff/Lindsay of this mitigation plan. DWR would like to emphasize two of her comments:

a. Specific-#17-As per the 2016 Guidance, DWR wants to see the trees planted by March 15th. If a later date is requested (in April) then the IRT should be notified. DWR will not accept any plantings into May unless the provider is willing to wait until the following growing season for monitoring year credit. Response: Based on recent USACE correspondence, mitigation plan approvals and upcoming guidance, it is our understanding that all tree planting must be completed by the end of April unless otherwise approved by the IRT. WLS will notify the IRT if planting is desired past March 15th as per the current 2016 Guidance and understands that planting at the end of May is no longer accepted or counted towards the first year of monitoring. Section 6.4.2, pg. 35 planting window language has been updated accordingly.

b. Plan sheets-#3-DWR advises not to build/grade a channel for the headwater stream credit. It appears a lot will be left up to the field engineer following microtopography grading. We have seen channels dug in these situations which look more like a ditch through wetlands than a headwater valley. Response: As described in Section 6.1.2 and illustrated on plan sheet #3 typical section for headwater channel, the existing ditches and channelized streams will be filled and graded to the natural valley topography prior to the pre-drained condition. The restored headwater reaches UT1 and UT2 will be relocated to the low point of the historic valley from the existing agricultural field to the wooded area as they flow towards their new confluence with MS2 and MS3. The final construction plans include a detailed grading plan with a proposed 3D surface model. The valley bottom will be graded to restore the natural microtopographic variability that is common within headwater systems. A shallow flow path will be constructed to form a small pilot channel similar to the adjacent reference sites described in Section 6.2.1. The pilot or primary channel will be approximately 2-4 ft wide and 0.3'-0.7' deep and not function as a ditch flowing through a wetland. The base flow will follow diffuse flow paths and spread out through these depressions, restoring a more natural hydrology function. The headwater channel morphology is expected to adjust as vegetation becomes established during the monitoring period.

2. Table 2-Reach Summary Information- DWR believes the drainage area limit for intermittent channels in the coastal plain should be 100 acres. Therefore, we believe that reaches UT1 and UT2 will be at risk for providing the proper flow to maintain channel requirements as per the 2016 Mitigation Guidance Update. Response: WLS understands this concern and acknowledges the risk associated with the smaller drainage areas (<100 acres) and intermittent stream flow requirements. Although the upper headwater catchments are in agricultural fields, the ditch network that flow into reaches UT1 and UT2 must remain open and active to maintain surface flow and drainage for crop production. As discussed during the IRT site visit, the adjacent headwater reference reach has a similar drainage area and valley slope (37 acres, 0.0079 ft/ft) as UT1 and UT1. Based on our extensive reference site evaluations and successful experience restoring headwater stream and wetland systems, we have found drainage area alone is not always reliable indicator for predicting surface flow duration and headwater stream morphology.

3. Section 3.1.4-DWR likes seeing the planned monitoring of macrobenthic invertebrates. Response: WLS will continue collecting this data, as appropriate, to document biological response and document functional uplift for our mitigation projects.

4. Section 3.4.5-The third paragraph stated that, "both USACE and DWR representatives agreed with headwater stream restoration approach…". As the minutes reflected, what was discussed was that 30 days was the minimum flow requirement and that it may not be enough to form channel characteristics. DWR believes these two tributaries are at a high risk attain stream restoration credit. I do recall visiting the reference reaches and thought they were good references for a headwater type approach to stream restoration. Response: The statement in the third paragraph in Section 3.4.5 references general comments provided during the PJD site with Emily Thompson and Kyle Barnes (USACE) and Anthony Scarbraugh (DWR). The paragraph has been revised to avoid confusion.

5. Section 5-Mitigation Project Goals and Objectives- this section (including Table 12) should include some verbiage about restoring wetland hydrology (where appropriate, especially around reach MS3). Response: Additional language was added to Section 5 describing wetland hydrologic functions will be also be improved by raising the local water table, especially around MS2 and MS3.

6. Section 6.4.2-Planting Materials and Methods-see comment #1a. Response: Please see response to DWR comment 1a.

7. Section 6.5-Water Quality Treatment Features-DWR likes the addition of these features. Response: WLS will continue to implement these WQ features, as appropriate, to reduce pollutant inputs to the project area and receiving waters.

8. Section 6.6.2-DWR likes the addition of wood to the headwater system, however, we do not like the appearance of the channel as it is shown on the design sheets. DWR prefers a wide shallow headwater valley with wood placed randomly and the channel formation taking place on its own. Response: WLS understands this comment and DWRs preference. We would like to clarify the headwater valley and bottom width will be graded approximately 15'-30' wide prior to the wood installation and pilot channel construction. The proposed design contours will allow the headwater channel morphology to vary between a poorly defined and moderately defined channel as shown on design plan sheet 3 and supported by the adjacent reference reach data. The representative photos below illustrate as-built conditions of a recently constructed HW stream and wetland complex with similar design parameters and characteristics as compared to the nearby 'South Reference Reach' system visited by Mac Haupt with DWR.

Headwater Valley Restoration – As-built Condition

Nearby South Reference Reach – Existing Condition

9. Design sheet 3-DWR likes the concept of the typical portrayed for the Headwater (Multithread-thread) channel, we are just concerned with the operator building more of a channel. The way the headwater reaches are drawn on the design sheets with straight channels and wood structures placed as sills and rootwads (placed as in a single thread channel) does not help the impression. Response: WLS understands this concern and we have selected reputable contractor that has recent experience in constructing headwater stream channels as opposed to just single-thread trapezoidal channels. As noted in DWR response comment #8 above and further described in Section 6.6, the headwater channels will not be straightened and the in-stream structures such as woody riffles/debris, log sills, and root wads will be placed throughout the headwater valley to improve floodplain and habitat functions.

10. Design sheet 14-The upper reach of UT2 shows two branches while in Figure 9 there is only one stream/valley. Are your valley footage calculations based on one valley length as in Fig. 9 or two as in sheet 14? DWR does not agree with there being two valleys at the top of UT2. Moreover, DWR is concerned with the top of both UT1 and UT2. Are the tops of both these reaches designed to accept the flow from the offsite ditches? If so, what if the landowner decides to cut a new ditch and thereby remove your primary hydrologic input? Response: WLS is not proposing an additional valley or stream credit at the top of UT2. The mitigation credits proposed in Table 1 and shown on design plan sheet #1 are based on valley length for headwater reaches UT1 and UT2. The creditable stream length begins at UT2 station 10+28 and UT1 station 10+68 respectively. The tops of both of these reaches are designed to accept flow from offsite ditches. We have added a note in Table 1 for clarification. As noted in DWR response comment #2, the upper headwater catchments are in agricultural fields, however the ditch network that flow into reaches UT1 and UT2 must remain open and active to maintain surface flow and drainage for crop production. WLS has coordinated closely with the landowner to ensure the ditches and drainage paths will not be altered post-restoration.

Travis Wilson, NCWRC:

1. The generic permanent stream crossing detail does not illustrate or mention the possible need for culverts set above bankfull elevation. It would be beneficial to including a cross section detail specific to each culverted stream crossing. That will allow a better assessment of the culvert sizing and configuration within the crossing. Response: The typical culvert crossing detail is not reach specific mainly to limit the number of details within the project plans, so as to minimize duplication and limit the number of plan sheets. Site specific culvert information is shown in the plan/profile sheets of the construction documents and design calculations are provided in Appendix 2. WLS has revised the permanent stream crossing detail to include a bankfull culvert where and when it is called out in the construction documents.

2. Note: duel lines of smaller diameter pipe in the channel are not preferred. Pipes typically have to be placed 12"-18" apart causing the channel flow to split and potentially over widen at the inlet and outlet. Response: WLS understands the concern about dual pipes but have had success with this design approach without deleterious effects to the stream. However, we have revised the current crossing detail to include a single channel culvert and floodplain culvert(s) with appropriate spacing.

Kim Browning, USACE:

1. Design Sheets: Please QC the Sheet Index and correct pages numbers. Response: The design sheet index has been corrected.

2. I agree with DWR's comment #2, and since UT2 was determined to be ephemeral, and both UT1 and UT2 both have small drainage areas, it will be necessary to demonstrate flow and the development of OHWM characteristics. Response: As noted in DWR response comment #2, we understand this concern and have included performance standards in Section 7.2 and headwater stream monitoring in Section 8.2.4 per USACE 2016 Guidance to demonstrate flow and development of OHWM characteristics.

3. Is it possible to move the crossing on MS1 to the top of the reach to prevent fragmentation? Response: It is not possible to move the crossing on MS1 to the top of the reach. The crossing was placed in its current location along MS1 due to property line constraints and landowner request.

4. Please ensure that the water quality BMPs proposed for UT1 and UT2 are not within the jurisdictional feature. Figures 9 and 10 show inconsistent origins of these two reaches. Response: The water quality features proposed for UT1 and UT2 are not within jurisdictional stream features. The proposed stream origins are located within the naturally restored headwater valleys and correct as shown in Figures 9 and 10.

5. Please add a veg plot to the area along MS2 where the existing wetland is. Response: A vegetation plot has been added in the existing wetland area and can be seen on Figure 10.

6. Please verify that the headwater valley lengths were measured using straight valley length. Response: The headwater valley lengths were measured using straight valley length using topographic survey and LiDAR imagery data.

7. Establishment of vegetative cover and vigor can be challenging on P-II restoration banks/benches, please include a discussion on how soil amendments will be addressed during construction and reference potential adaptive management. Response: WLS agrees with this concern will incorporate soil amendments in PII cut banks/benches as needed. Added language in Section 6.6.1. Vegetation planting and establishment will be done in accordance with the technical specifications, the contractor shall apply all soil amendments, such lime and fertilizer, as specified by soil test results along with temporary and permanent seed and mulch immediately prior to installing erosion control matting.

8. Section 6.4.2: Please reference the planting window specified in the 2016 NCIRT Mitigation Update Guidance. This section references planting by the end of May, and in general, April 30th would be the last day to finish plantings to ensure that this year can be considered the first growing season for monitoring purposes. Decisions on how individual sites may be affected by not meeting this deadline have to be made by the IRT, in consideration of a number of factors. Response: Please see the response to DWR comment 1a.

9. Section 7.1: Stream Hydrology-please add that at least 30-days consecutive flow must be measured for intermittent (and ephemeral) streams. Response: The statement that stream hydrology must have at least 30 days of consecutive flow is found under section 7.1 in the Jurisdiction Stream Flow section.

10. Table 20: Regarding the note indicating "species substitutions may occur due to availability or refinement", please red-line the As-Built and MY0 report if substitutions occur. Response: The note under Table 20 has been updated, a red-line copy of the table will be included in the as-built and MY0 report if a substitution occurs.

11. Please add a section regarding potential future risks and uncertainties, such as adjacent development, beaver, road/culvert maintenance, encroachments, or ditching by adjacent landowner. The concern was raised that raising the ditch elevation to the same as the surrounding land would result in significant rehydration of the surrounding farm fields. This could cause problems for the adjacent land use and may lead to additional drainage ditches being installed by the landowner. This would conflict with goals of the project especially where headwater valley restoration approaches are used, because the goal with this approach is to create wetlands within the valley. Response: WLS added Section 3.5.7 in the mitigation plan to address future potential site risks and uncertainties. We understand the concern of raising the ditch elevation and the potential impact on the surrounding farm fields. The landowner has indicated they are planting wet tolerant crops in these fringe buffer areas and a majority of the ditch network (~3,700 feet) will remain open in the UT1 and UT2 drainage areas.

12. Section 8.1: Please show the location of the fixed photo points on Figure 10. If cross-sections are to be used for photo points, please indicate in the text. Additionally, it would be helpful to have photo points at crossings to show the condition of the culverts. Response: Language has been added to Section 8.1 stating that the fixed photo points are to be located at the cross-sections. A photo point at the two crossing locations will be added as well and will be shown on the monitoring CCPV map.

13. Please show the location of the rain gauge on Figure 10. Response: The location of the rain gauge has been added to Figure 10.

Please contact me if you have any additional questions or comments.

Sincerely,

Water & Land Solutions, LLC

Kayne Van Stell

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DEPARTMENT OF THE ARMY
WILMINGTON DISTRICT, CORPS OF ENGINEERS
69 DARLINGTON AVENUE
WILMINGTON, NORTH CAROLINA 28403-1343

REPLY TO
ATTENTION OF:

July 6, 2020

Regulatory Division

Re: NCIRT Review and USACE Approval of the NCDMS Hornpipe Branch Tributaries Mitigation Site / Lenoir Co./ SAW-2018-01762/ NCDMS Project # 100076

Mr. Tim Baumgartner
North Carolina Division of Mitigation Services
1652 Mail Service Center
Raleigh, NC 27699-1652

Dear Mr. Baumgartner:

The purpose of this letter is to provide the North Carolina Division of Mitigation Services (NCDMS) with all comments generated by the North Carolina Interagency Review Team (NCIRT) during the 30-day comment period for the Hornpipe Branch Tributaries Draft Mitigation Plan, which closed on May 16, 2020. These comments are attached for your review.

Based on our review of these comments, we have determined that no major concerns have been identified with the Draft Mitigation Plan, which is considered approved with this correspondence. However, several minor issues were identified, as described in the attached comment memo, which must be addressed in the Final Mitigation Plan.

The Final Mitigation Plan is to be submitted with the Preconstruction Notification (PCN) Application for Nationwide permit approval of the project along with a copy of this letter. Issues identified above must be addressed in the Final Mitigation Plan. All changes made to the Final Mitigation Plan should be summarized in an errata sheet included at the beginning of the document. If it is determined that the project does not require a Department of the Army permit, you must still provide a copy of the Final Mitigation Plan, along with a copy of this letter, to the appropriate USACE field office at least 30 days in advance of beginning construction of the project. Please note that this approval does not preclude the inclusion of permit conditions in the permit authorization for the project, particularly if issues mentioned above are not satisfactorily addressed. Additionally, this letter provides initial approval for the Mitigation Plan, but this does not guarantee that the project will generate the requested amount of mitigation credit. As you are aware, unforeseen issues may arise during construction or monitoring of the project that may require maintenance or reconstruction that may lead to reduced credit.

Thank you for your prompt attention to this matter, and if you have any questions regarding this letter, the mitigation plan review process, or the requirements of the Mitigation Rule, please call me at 919-554-4884, ext 60.

Sincerely,

Kim Browning
Mitigation Project Manager
for Tyler Crumbley

Enclosures

Electronic Copies Furnished:

NCIRT Distribution List
Lindsay Crocker—NCDMS
Catherine Manner, Kayne Van Stell—WLS

Prepared by:

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This mitigation plan has been written in conformance with the requirements of the following:

- Federal rule for compensatory mitigation project sites as described in the Federal Register, Title 33, Navigation and Navigable Waters, Volume 3, Chapter 2, Section § 332.8, paragraphs (c)(2) through (c)(14).
- NCDEQ Division of Mitigation Services In-Lieu Fee Instrument, signed and dated July 28th, 2010.

These documents govern NCDEQ Division of Mitigation Services operations and procedures for the delivery of compensatory mitigation.

Kayne M. Van Stell
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1 Project Introduction

The Hornpipe Branch Tributaries Mitigation Project ("Project") is a North Carolina Department of Environmental Quality (NCDEQ), Division of Mitigation Services (DMS) full-delivery project, contracted with Water & Land Solutions, LLC (WLS) in response to RFP 16-007401. The Project will provide stream mitigation credits in the Neuse River Basin (Cataloging Unit 03020202). The project site is located in Lenoir County, North Carolina, in the Community of Deep Run at coordinates 35.134242° North and -77.655045° West. The Project site is located in the Targeted Local Watershed 03020202050010 (Warm Water Thermal Regime) of the Neuse River Basin (Figure 1).

The Project will involve the restoration of five stream reaches (Reaches MS1, MS2, MS3, UT1 and UT2) and their riparian buffers, totaling approximately 5,151 creditable feet of streams. The Project will provide significant ecological improvements and functional uplift through stream restoration and decreasing nutrient and sediment loads within the watershed. See Section 5 for a detailed benefits summary and Table 1 for a summary of project assets. Figure 9 illustrates the project mitigation components.

Table 1. Project Asset Summary

Project Component	Type of Mitigation (Priority Level)	Creditable Units (LF)	Mitigation Ratio (X:1)	Stream Mitigation Credits (SMCs)
MS1	Stream Restoration (PI/PII)	1,440	1	1,440.000
MS2	Stream Restoration (PI)	943	1	943.000
MS3	Stream Restoration (PI/PII)	1,529	1	1,529.000
UT1	Stream Restoration (PI/HW)	677	1	677.000
UT2	Stream Restoration (PI/HW)	562	1	562.000
Totals		**5,151**		**5,151.000**
Note 1: No mitigation credits were calculated outside the conservation easement boundaries.				
Note 2: Mitigation credits were based on valley length for headwater reaches UT1 and UT2.				

The site involves a series of unnamed headwater tributaries to Hornpipe Branch. Hornpipe Branch flows northwest to its confluence with Southwest Creek northeast of Deep Run, North Carolina. Hornpipe Branch is listed by the NCDEQ Division of Water Resources as a Class C and Nutrient Sensitive Water (NSW) from source to Southwest Creek. The project site is in the Rolling Coastal Plain ('65m') US Environmental Protection Agency Level IV Ecoregion and the North Carolina Coastal Plain Physiographic Province (Omernik, 2014).

2 Watershed Approach and Site Selection

In an effort to focus its watershed prioritization process, DMS developed the Neuse River Basin Restoration Priorities in 2010 (Amended August 2018) to guide restoration activities within the river basin. The project area is located in the Southwest Creek watershed (HUC: 03020202050010). Priorities to be addressed in this watershed include stream buffers, unstable streambanks, and agricultural runoff (RBRP, 2018). The Project site is situated in the Coastal Plain, NCDEQ Sub-basin 03-04-05, in the Targeted Local

Watershed 03020202050010, all of the Neuse River Basin (Figure 1). The land use within the project area is comprised of mostly forest and agriculture, with a small percentage of low-density residential use. The proposed in-stream restoration practices will improve habitat diversity (e.g. restore floodplain and provide deeper pools and backwater areas) and promote native species propagation throughout the conservation easement (FISRWG, 1998). Additionally, water quality treatment features will be incorporated to reduce direct nutrient inputs and pollutant contamination to the Project streams.

Expected benefits to aquatic resource functions, as a result of implementing this project are further described in the 2018 RBRP. Developing specific goals and objectives that directly relate to functional improvement is a critical path for implementing a successful restoration project. The expected functional uplift is discussed further and in more detail under Section 4, and project goals and objectives are further described and discussed under Section 5.

3 Baseline Information and Existing Conditions Assessment

WLS performed an existing conditions assessment for the Project by compiling and analyzing baseline information, aerial photography, and field data. The purpose of this assessment was to determine how aquatic resource functions have been impacted within the catchment area. Watershed parameters such as drainage patterns, percent impervious cover, controlling vegetation and hydrology (rainfall/runoff relationships) were evaluated, along with the analysis of physiography, local geology, soils, topographic position (basin relief, landforms, valley morphology), and flow regime (discharge, precipitation, sediment supply).

Combined with historical context, the processes of hydrology and geomorphology must be linked to evaluate current physical and biological conditions and system responses to human activities within the riparian ecosystem (Montgomery and Bolton, 2003). Identifying the hydrogeomorphic variability, site constraints, and cause-and-effect relationships plays a key role in determining the functional loss and maximizing potential uplift (Harman et al., 2012). The following sub-sections further describe the existing site conditions, degrees of impairment, and primary controls that were considered for developing an appropriate restoration design approach. Table 2 represents the project attribute data and baseline summary information.

Table 2. Project Attribute Data and Baseline Summary Information

Project Information					
Project Name	Hornpipe Branch Tributaries Mitigation Project				
County	Lenoir				
Project Area (acres)	23.4				
Project Coordinates (latitude and longitude)	35.134242°, -77.655045°				
Planted Acreage (acres of Woody Stems Planted)	13.2				
Project Watershed Summary Information					
Physiographic Province	Coastal Plain				
River Basin	Neuse				
USGS Hydrologic Unit	03020202050010				
DWR Sub-basin	03-04-05				
Project Drainage Area (acres)	331 acres				
Project Drainage Area Percentage of Impervious Area	2.0%				
CGIA Land Use Classification	2.01.03, 2.01.01, 3.02 (78% cultivated crops, 16% evergreen/mixed forest)				
Reach Summary Information					
Parameters	MS1	MS2	MS3	UT1	UT2
Existing Reach Length (linear feet)	1,493	774	1,548	498	644
Valley confinement (Confined, moderately confined, unconfined)	unconfined	unconfined	unconfined	unconfined	unconfined
Drainage area (acres)	183	222	331	46	32
Perennial, Intermittent, Ephemeral	Intermittent	Perennial	Perennial	Intermittent	Ephemeral
NCDWR Water Quality Classification	C, NSW	C, NSW	C, NSW	C, NSW	C, NSW
Stream Classification (existing)	N/A (Channelized)	N/A (Channelized)	F5	N/A (Channelized)	N/A (Channelized)
Evolutionary trend (Simon)	IV	IV	III/IV	IV	IV
FEMA classification	N/A	N/A	N/A	N/A	N/A

Regulatory Considerations			
Parameters	Applicable?	Resolved?	Supporting Docs?
Water of the United States - Section 404	Yes	Pending	404 Permit
Water of the United States - Section 401	Yes	Pending	401 Permit
Endangered Species Act	Yes	Yes	Categorical Exclusion
Historic Preservation Act	Yes	Yes	Categorical Exclusion
Coastal Zone Management Act (CZMA or CAMA)	No	N/A	N/A
FEMA Floodplain Compliance	No	N/A	N/A
Essential Fisheries Habitat	No	N/A	Categorical Exclusion

3.1 Watershed Processes and Resource Conditions

3.1.1 Watershed Overview

Historic channelization and ditching activities have influenced the overall system response in multiple reach segments across the Project site. Measurable changes in the landscape ecology were first identified upon review of historic aerial photography, including native buffer vegetation disturbance and/or removal and stream channel alteration. Evidence of these observed changes were documented throughout the watershed as channelized streams, decreased riffle-pool frequency and bedform diversity, as well as limited floodplain connectivity, drained wetland hydrology and hyporheic zone interaction. Additionally, agricultural fertilization has likely increased nutrient levels within the watershed. These ecological impacts have negatively impacted historic stream and wetland functions at the site and have likely increased over the past few decades due to anthropogenic changes within catchment.

3.1.2 Surface Water Classification

Hornpipe Branch is classified as Class 'C' and Nutrient Sensitive Water (NSW) (Stream Index 27-80-3) "From source to Southwest Creek". Class 'C' waters are protected for secondary recreation, fishing, wildlife, fish and aquatic life propagation and survival, agriculture and other uses suitable for Class 'C'. NSW waters is a supplemental classification intended for waters needing additional nutrient management due to being subject to excessive growth of microscopic or macroscopic vegetation.

3.1.3 Aquatic Resource Health and Function

WLS reviewed DWR biological and water quality data within the Hornpipe Branch watershed to identify any potential stressors near receiving waters. Currently, no DWR water quality monitoring stations, or benthic or fish monitoring stations exist in the project watershed. At this time, no known DWR monitoring sites are proposed for monitoring use by WLS for this project.

It is generally accepted that nutrient loading and sedimentation from streambank erosion and agricultural practices are significant pollutants to water quality and aquatic habitat. However, there can be data uncertainties and excessive costs for monitoring nutrient levels and sediment delivery in streams (HESS, 2014). Without an extensive nutrient monitoring and management plan, types, application rates, groundwater leaching, and lag times can vary considerably, making it difficult to quantitatively determine water quality improvements in response to the proposed restoration practices.

3.1.4 Benthic Macroinvertebrates and Aquatic Habitat

WLS will sample benthic macroinvertebrate (BMI) communities and aquatic habitat at one location along MS3 within the project area. The sample location will be selected based on stream length, watershed position and flow regime. Macroinvertebrates are useful biological monitors because they are found in all aquatic environments, are less mobile than many other groups of organisms, and easily collectable. BMI sampling will be conducted using methods and procedures defined by DWR's "*Standard Operating Procedures for the Collection and Analysis of Benthic Macroinvertebrates*" (NCDWR, 2016). Sampling will be conducted before the stream restoration activities during the Spring/Summer of 2020 and additional sampling will be conducted again in Spring/Summer during the third year of post-construction monitoring. Pre-existing conditions data will be included in the As-built baseline report (MY0) post-construction.

3.1.5 Pollutant Load Estimations

STEPL Model: WLS utilized the Spreadsheet Tool for Estimating Pollutant Loads (STEPL v4.3, 2015) to help quantify how the project may reduce pollutant loads into the Hornpipe Branch Watershed. The STEPL model was developed for the United States Environmental Protection Agency (USEPA, Tetra Tech, 2015) and was used to estimate sediment and nutrient load reductions from the implementation of agricultural BMPs, such as wetland detention, and bank stabilization/stream restoration. Model inputs include land use information, Revised Universal Soil Loss Equation (USLE)/runoff curve numbers, eroded streambank length, streambank height, lateral recession rates, soil type/weight, and BMP type/efficiency applicable to the Coastal Plain region. The summary of total annual pollutant loadings and removal estimates are shown Table 3 below.

Table 3. Total Annual Pollutant Loadings and Removal Estimates from the STEPL Model

Project Watershed (ac)	Existing Length Assessed (ft)	Length of Scoured Bank (ft)	Sediment Load (ton/yr)	Nitrogen Load (lb/yr)	Phosphorus Load (lb/yr)	Sediment Reduction w/ BMP (ton/yr, %)	Nitrogen Reduction w/ BMP (lb/yr, %)	Phosphorus Reduction w/ BMP (lb/yr, %)
331	6,362	3,180	319.2	2,009.4	555.6	120.8 37.8%	743.0, 37.0%	204.0, 36.7%

Note 1: Soil Texture Class is predominantly fine sandy loam.
Note 2: Average Bank heights in scour areas ranged 2 to 3 feet.
Note 3: Lateral Recession Rates (ft/yr) ranged from slight category (0.01 to 0.05) to moderate (0.06 to 0.20)
Note 4: Agricultural BMP input used for streambank stabilization/restoration.

Although the STEPL model data is more empirically based, it is intended to be used as a basic planning tool. Inherently, there are certain assumptions and limitations that must be considered when refining model inputs and evaluating the results. For example, water quality calculations and sediment loading are highly dependent on actual BMP efficiencies, sophisticated algorithms, regression analysis, and not calibrated field measurements.

BANCS Method: As a comparison to the STEPL model results for sediment loading, WLS predicted streambank erosion rates and annual sediment yields using the Bank Assessment for Non-point-source Consequences of Sediment (BANCS) method (Rosgen 1996, 2001a) which considers two streambank erodibility estimation tools: The Bank Erosion Hazard Index (BEHI) and Near Bank Stress (NBS). This rating method is used to describe existing streambank conditions (i.e., bank migration and lateral stability) and quantify the lateral erosion potential of a stream reach in feet per year. The components of the BANCS methodology can be subjective and vary based on the region's climatic condition, geologic controls, and the experience level and professional training of the observers. However, it is a repeatable estimation method and the intent is to be used as a relative comparison for pre- and post-restoration conditions.

WLS used the unpublished NC Piedmont BEHI and NBS ratings curve (personal communication with NRCS, Walker, 2016) to estimate annual sediment loss based on local observations and streambank measurements taken in December 2019. The BEHI/NBS estimates for the existing conditions (pre-construction) predict that the project reaches contribute approximately 134.3 tons of sediment per year to Hornpipe Branch. The BEHI ratings varied from 'very low' to 'high' based on minimal shear stress, stream bed/bank stability and lower valley slopes. The average 'low-moderate' BEHI ratings and observations are typical of a degraded stream system with that has been channelized with localized yet active bank erosion. See Table 4 below and Appendix 2 for sediment loading assessment sheets.

Table 4. BANCS Reach Assessment

Project Component	BEHI Range	NBS Range	Sediment Loading (tons/yr)
MS1	Very Low/Low-Mod	Very Low	36.2
MS2	Very Low/Low-Mod	Very Low	6.9
MS3	Low/High	Very Low/Mod	60.2
UT1	Moderate	Low	29.8
UT2	Moderate	Low	31.2

3.2 Landscape Characteristics and Regional Controls

3.2.1 Physiography and Geology

The project site is located in the Rolling Coastal Plain Ecoregion. This Ecoregion is characterized by dissected irregular plains and smooth plains; broad interstream divides with gentle to steep side slopes dissected by numerous small, low to moderate gradient sandy bottomed streams. The project site is also located in the Coastal Plain Belt. More specifically, the geologic unit is classified as 'Kp', or the Peedee Formation, which is characterized by sand, clayey sand, and clay; greenish grey to olive black; massive, glauconitic; locally fossiliferous and calcareous; patches of sandy molluscan-mold limestone in upper part (USGS, 1998).

3.2.2 Soils

Soils at the project site were initially determined using NRCS soil survey data for Lenoir County (NRCS Lenoir County Soil Survey, 1977). The soils within the project area were verified during on-site field investigations. Figure 4b illustrates soil conditions throughout the project area and the soil descriptions are provided below in Table 5.

Table 5. Project Soil Type and Descriptions

Soil Name	Hydric	Description
Craven fine sandy loam (Cr) (0.70% of easement)	No	Moderately well drained soils formed on flats on marine terraces or ridges on marine terraces in the Coastal Plain Region. Slopes range from 1 to 4% on landscapes with wooded-mixed hardwoods and pine. Areas are typically cultivated. Silt loam surface with a silty clay subsurface.
Johnston soils (JS) (66.0% of easement)	Yes	Very poorly drained soils formed mainly on floodplains and swamps in the lower to upper Coastal Plain Region that are frequently flooded. Slopes range from 0 to 2% on wooded landscapes dominated by hydric species. Mucky loam surface layer and loamy fine sand underlying material.
Norfolk loamy sand (Nb) (20.0% of easement)	No	Consists of nearly level to sloping, well-drained soils on uplands with a surface layer of yellowish-brown sandy loam and very fine sandy loam typically 4-8 inches thick. Slopes range from 2 to 6% on land that is predominantly used for crops.
Pocalla loamy sand (Po) (11.6% of easement)	No	Consists of nearly level to gently sloping, somewhat excessively drained soils on uplands with a surface layer of sand and a sub-soil of loamy sand. Slope ranges from 0 to 6% on land that is predominately used for crops.

As shown on the NRCS Soils Map (Figure 4a), existing floodplain soils around the project reaches are mostly within the mapping units JS and Nb. Johnston soil series (JS) are classified as 'Hydric A'. It is anticipated that as a direct result of implementing Priority Level I stream restoration, headwater valley restoration and revegetation, the natural hydrology will be restored and allow the streams to regain their natural/historic functions.

3.2.3 Climate

The Project site is located in Lenoir County, NC which has short, mild winters and long, hot summers (NRCS, 1977). The average growing season for the Project site is 225 days, beginning on March 27th and ending November 7th (NRCS Lenoir County Soil Survey, Weather Station: Kinston, NC). The average annual precipitation in the Project area is approximately 50.4 inches with a consistent monthly distribution, except for convective storm events or hurricanes that occur during the summer and fall months. In 2019, the area received 38.9 inches as shown on WETS Table 6. Over the past 48 months, the Kinston weather station (Station: KINS – Cunningham Research Station) has recorded over 214 inches of rain.

Table 6. Comparison of Monthly Rainfall Amounts vs. Long-term Averages

Month-Year	Observed Monthly Precipitation (in)	WETS Average Monthly Precipitation (in)	Deviation of Observed from Average (in)
Jan-19	2.48	3.88	-1.40
Feb-19	3.01	3.38	-0.37
Mar-19	3.49	3.97	-0.48
Apr-19	3.19	3.37	-0.18
May-19	1.69	3.89	-2.20
Jun-19	5.22	5.01	+0.21
Jul-19	4.71	5.68	-0.97
Aug-19	4.59	5.67	-1.08
Sep-19	2.2	5.73	-3.53
Oct-19	2.17	3.31	-1.14
Nov-19	3.78	3.12	+0.66
Dec-19	2.34	3.39	-1.05
Sum	**38.87**	**50.39**	**-11.52**

Throughout much of the southeastern US, average rainfall often exceeds average evapotranspiration (ET) losses and areas experience a moisture excess during normal years, which is typical of the Project site. Excess water leaves the Project site by groundwater flow, surface runoff, channelized surface flow, or seepage. Annual losses due to seepage, or percolation of water are not considered a significant loss pathway for excess water. However, groundwater flow and the hyporheic exchange is critical in small headwater stream systems like those at the Project site, as most excess water is lost via surface and shallow subsurface flow. The Project streams' drainage density relative to the geomorphic/geologic character and hydrologic regime is common given the seasonal rainfall patterns, slower runoff rates, headwater topographic relief, groundwater recharge, and moderate infiltration capacity/depth to impermeable layer. Further observations of perennial flow frequency, response time to storm events, streambank erosion rates and groundwater saturation over the past year support this conclusion.

3.2.4 Existing Vegetation

Historical land management surrounding the Project area has been primarily for agricultural and silvicultural purposes. Prior to anthropogenic land disturbances, the riparian vegetation community likely consisted of Mesic Mixed Forest (Coastal plain Subtype) in the uplands with Coastal Plain Small Stream Swamp in the floodplains (Schafale 2012). The existing vegetation within the project area consists mostly of agricultural fields. The majority of the riparian and upland areas have no buffer as a result of clearing and ditching for agricultural purposes. The riparian area surrounding MS3 contains mixed hardwood forest and invasive species, primarily Chinese privet.

Table 7. Existing Site Vegetation

	Common Name	Scientific Name
Canopy Vegetation	Red maple	*Acer rubrum*
	Yellow-poplar	*Liriodendron tulipifera*
	Loblolly pine	*Pinus taeda*
	Sweetgum	*Liquidambar styraciflua*
	Slippery elm	*Ulmus rubra*
	White oak	*Quercus alba*
Understory & Woody Shrubs	American Holly	*Ilex opaca*
	Ironwood	*Carpinus caroliniana*
	Chinese privet	*Ligustrum sinense*
	Eastern red cedar	*Juniperus virginiana*
Herbaceous & Vines	Poison ivy	*Toxicodendron radicans*
	Switchcane	*Arundinaria tecta*
Herbaceous & Vines	Greenbrier	*Smilax rotundifolia*
	Multiflora rose	*Rosa multiflora*
	Broadleaf cattail	*Typha latifolia*
	Japanese stiltgrass	*Microstegium vimineum*
	Soft rush	*Juncus effusus*

3.3 Land Use

The USGS 2011 National Land Cover Data GIS Dataset and StreamStats was used to estimate the current impervious cover and land use information for the project catchment area. The catchment area has an impervious cover approximately 2% and the dominant land uses are 78% cultivated crops, 16% mixed forest, and 4% grassland/herbaceous. WLS conducted extensive field reconnaissance to verify the current land use practices within the catchment, which include active agricultural land managed for hay/row crop, timber production, as well as mixed forest. Prior to the 1950s, most of the watershed was agricultural land or mixed forest as illustrated on historic aerials (See Figures 7a). WLS was unable to obtain land use information prior to the 1950s. By the early 2000s, the majority of the Project area had been converted to agricultural land with no development trends within the project timeline. Over time the natural stream processes and aquatic resource functions have been significantly impacted because of these historic anthropogenic disturbances.

3.4 Watershed Disturbance and Response

To determine what actions are needed to restore the riparian corridor structure and lift ecological functions, it is critical to examine the rates and type of disturbances, and how the system responds to those disturbances. Across the Project site, landowners historically manipulated and/or straightened streams and ditched riparian wetland systems to provide areas for crop production and silviculture. These activities have caused changes to channel patterns, sediment transport, in-stream habitat, thermal regulation, and dissolved oxygen (DO) content.

As shown in the historical aerial photographs (See Figures 7a, 7b, 7c, and 7d), the riparian buffer areas, except MS3, have been heavily impacted from historic and current land use practices, including agriculture and silviculture. Historic manipulation of the stream channels has severely impacted the streambanks and natural flow patterns throughout the Project. The streams in the Project area are incised and the floodplain connection has been lost in many locations. The past land use disturbances, active channel degradation, and current land use practices present a significant opportunity for improving water quality and ecosystem functions through the implementation of this project. Figure 7d show the most recent aerial photography depicting the most current land use of the Project.

3.4.1 Existing Reach Condition Summary

The streams at the Project site were categorized into five reaches (MS1, MS2, MS3, UT1, and UT2) totaling approximately 4,957 linear feet of existing streams. Reach breaks were based on the drainage area at confluences, changes in existing condition, restoration/enhancement approaches, and/or changes in stream status. Copies of the DWR Stream Identification Forms and correspondence are included in Appendix 7 and existing reach condition summaries are provided below.

Photo of MS1 showing lack of riparian buffer and straightening for agricultural purposes.

MS1: MS1 is a headwater tributary that has been channelized and straightened along its entire length. The upstream end of MS1 drains a ditch network that appears to have been dug through historic non-riparian wetlands. The valley slope is approximately 0.6 percent and the drainage area is 183 acres. The majority of the drainage area for MS1 is within active agricultural fields.

MS1 drains to its confluence with a small headwater tributary, UT4 (not included with this project) to begin MS2. Because the system has been channelized, the sinuosity is essentially non-existent (k=1.01). The channel dimension of MS1 currently is a trapezoidal channel with a top width of approximately 11.5 feet, a depth of approximately 3.1 feet, and 1.5:1 side slopes. The typical Bank Height Ratio (BHR) for MS1 was measured to be 2.6.

The riparian buffer along the entire length of MS1 consists of active agricultural fields, with no woody vegetation, as the streambanks are regularly mowed and maintained. The landowner has consistent problems with streambank collapse and associated soil loss along this reach. Based on the poor channel conditions and historic anthropogenic disturbances, including channelization and straightening, MS1 was not classified.

Looking downstream to the confluence of MS2 and UT2 from existing culvert crossing.

MS2: MS2 continues as an unnamed tributary that has been channelized although appears to generally be at the historic valley centerline/low point along most of its length. The valley slope is approximately 0.4 percent and the drainage area is 222 acres. The majority of the drainage area for MS2 is active agricultural fields. Near the downstream end of MS2, there is a historic in-line agricultural BMP that was constructed decades ago as stormwater wetland. The landowner noted that this was implemented by the Lenoir County Soil and Water Conservation District and that it was the first such BMP installed in the County. MS2 drains to its confluence with UT2 to begin MS3.

Because the system has been channelized, the sinuosity is very low (k=1.01). The dimension of MS2 currently is a trapezoidal channel with a top width of approximately 10.5 feet, a depth of approximately 2.8 feet, and 1.5:1 side slopes. The typical BHR for MS2 was measured to be 2.2. The riparian buffer along the entire length of MS2 consists of active agricultural fields, with no woody vegetation, as the streambanks are regularly mowed and maintained, except at the described in-line BMP. Based on the poor channel conditions and historic anthropogenic disturbances, including channelization and straightening, MS2 was not classified.

Looking upstream at an incised channel and the unstable bed and bank conditions of MS3.

MS3: MS3 continues from MS2 to the downstream end of the project boundary at a culvert under Sandy Foundation Road. MS3 has been channelized and straightened along much of its length, as evidenced by the spoil piles and levees along the floodplain. MS3 entrenchment ratio (ER) is 1.1 and lacks natural stream bed features. This reach exhibits active streambank erosion and associated soil loss. The valley slope is approximately 0.4 percent and the drainage area is 331 acres. The majority of the drainage area for MS3 is active agricultural fields with an adjacent forested area. Because the stream system has been channelized, the sinuosity is very low (k=1.02). The typical BHR for MS3 was measured to be 4.8. The riparian buffer along the entire length of MS3 is mostly wooded. Based on the existing conditions and sand and clay bed materials, MS3 is classified as a Rosgen 'F5' stream type.

Looking at channel straightening and lack of riparian buffer on UT1.

UT1: UT1 is a small headwater tributary that has been channelized and straightened along its entire length, such that it is not at the historic valley centerline/low point. The valley slope is approximately 0.8 percent and the drainage area is approximately 46 acres. The entire drainage area for UT1 is within active agricultural fields. The channel is the main stem of a ditch network and is fed by two other ditches at its upstream end.

UT1 currently drains to its confluence with UT2, immediately upstream of where UT2 and MS2 drain together to begin MS3. Spoil levees are evident just inside the woods along the western side of the length of UT2 that flows adjacent to the forested area drained by MS3. Because the system has been channelized, the sinuosity is very low (k=1.06). The dimension of UT1 currently is a trapezoidal channel with a top width of approximately 11.0 feet, a depth of approximately 3.5 feet, and 2:1 side slopes. The typical BHR for UT1 was measured to be 3.3.

UT2: Similar to UT1, UT2 is a small headwater tributary that has been channelized and straightened along its entire length, such that it is not at the historic valley centerline/low point. The valley slope is approximately 0.6 percent and the drainage area is 32 acres. The entire drainage area for UT2 is active agricultural fields. The channel is fed by two other ditches at its upstream end. UT2 drains together with MS2 to begin MS3. Because the system has been channelized, the sinuosity is very low (k=1.06). The dimension of UT2 currently is a trapezoidal channel with a top width of approximately 11.0 feet, a depth of approximately 2.7 feet, and 1.5:1 side slopes. The typical BHR for UT2 was measured to be 4.7.

Photo of UT2 showing channel modification and lack of riparian buffer.

The riparian buffer along the entire length of UT2 consists of active agricultural fields, with no woody vegetation, as the streambanks are regularly mowed and maintained. Based on the poor channel conditions and historic anthropogenic disturbances, including channelization and straightening, UT2 was not classified.

3.4.2 Channel Morphology and Stability Assessment

WLS conducted geomorphic and ecological assessments for each Project reach to assess the current stream channel condition and overall lateral and vertical stability. Data collection included six representative riffle cross-sections, longitudinal profiles, and bulk sediment samples. The existing channel morphology is summarized in Table 8 and detailed geomorphic assessment data is included in Appendix 2. Consistent geomorphic indicators of the bankfull stage were difficult to identify in the field given the modified flow regime and channelized stream conditions. Therefore, bankfull cross-sectional areas were initially compared with the published NC Coastal Plain Regional Curve (Sweet and Geratz, 2003). See Appendix 2 for regional curve comparison plots. The BHRs were measured in the field to assess the degree of channel incision. BHR values greater than 1.5 typically indicate the stream channel is disconnected from its floodplain and system wide self-recovery is considered unlikely to occur within a desired timeframe (Rosgen, 2001). Entrenchment Ratios (ER) were also measured to determine the degree of vertical confinement.

Table 8. Existing Channel Morphology Summary

Project Reach Designation	Watershed Drainage Area (Ac)[1]	Entrenchment Ratio (ER)	Width/Depth Ratio (W/D)	Bank Height Ratio (BHR)	Sinuosity (K)	Channel Slope (S, ft/ft)	D_{50} (mm)
MS1	183	2.1	4.7	2.6	1.01	0.0050	<2
MS2	222	2.0	4.5	2.2	1.01	0.0041	<2
MS3	331	1.1	12.7	4.8	1.02	0.0044	<2
UT1	46	1.6	11.5	3.3	1.01	0.0065	<2
UT2	32	1.6	6.8	4.7	1.01	0.0071	<2

Note 1: Watershed drainage area was approximated based on topographic and LiDAR information and compared with USGS StreamStats at the downstream end of each reach.
Note 2: Cross-section locations are shown on Figure 6, Current Conditions Map.
Note 3: Geomorphic parameters for project reaches are based on best professional judgment and field measurements.
Note 4: Additional values and dimensionless ratios for meander geometry and facet slopes are provided in Appendix 2. The existing channel parameters are compared to stable reference stream systems in the Coastal Plain Physiographic Region.

WLS also compared historic aerial photographs with BANCS model estimates (Rosgen, 2006) described in Section 3.1.5 to identify areas susceptible to lateral stream bank erosion. BEHI/NBS rating forms are located in Appendix 2. Based on this comparison, most of the laterally unstable reach segments have occurred after the channels were straightened and riparian buffers where removed over the past few decades. As described in the reach condition summaries, the average valley slopes range from 0.4 to 0.8 percent and channel sinuosities range from 1.01 to 1.02. Most of the vertical grade control along the project reaches appears to be provided by the existing culvert crossings. The surveyed longitudinal profile indicates the reach segments have been heavily manipulated, contain poor bedform diversity and minimal habitat features with shallow pools and longer/flatter riffles with higher pool-to-pool spacing.

NC SAM: WLS completed stream evaluations of the Project reaches using the *NC Stream Assessment Method* (NC SAM, Version 2.1, 2015) developed by the NC Stream Functional Assessment Team (SFAT). The purpose of NC SAM is to provide the public and private sectors with an accurate, consistent, rapid, observational, and science-based field method to determine the level of function of streams within North Carolina. NC SAM can be used as a tool for the consideration of project restoration design and planning, allowing for impacts to be avoided and/or minimized, and to provide information concerning assessed stream characteristics and functions for the regulatory review process.

WLS evaluated the NC SAM metrics relevant to the project assessment reaches, as shown in Appendix 8. The metrics were documented to evaluate various stream functions. Project reaches MS1, MS2, UT1, and UT2 scored 'low' due to unstable channel and bank conditions, lack of riparian buffer, and altered stream morphology. Reaches MS3 scored 'low' because of stream incision, no access to the active floodplain, and excessive sedimentation and erosion. These channel stability and ecological assessments incorporated qualitative and quantitative observations using historic aerials, field evaluations, and detailed topographic survey data collected across the site. The conclusions from the NC SAM assessments help describe the current stream stability, ecological conditions and functional ratings, however, these methods are not intended to be used for determining mitigation success on constructed stream sites.

3.4.3 Channel Evolution

The modified Simon Channel Evolution Model (CEM) describes a predictable sequence of change in a disturbed channel system (Simon, 1989). Channel evolution typically occurs when a stream system begins to change its morphologic condition, which can be a negative or positive trend towards stability. The channel evolution processes and stage vary across the Project site and have been greatly affected by human-induced disturbances. After reviewing the channel dimension, plan form, and longitudinal profile information, WLS concluded that project reach MS3 varies between Class 'III' and 'IV' of the CEM as evidenced by an active migrating headcut and will likely continue to degrade and widen. The remaining reaches MS1, MS2, UT1 and UT2 are straightened/ditched and classified as Class 'IV' as evidenced by channel widening and slight fine sediment aggradation.

3.4.4 Sediment Supply, Delivery and Storage

Representative bed materials were bulk sampled from reaches MS3 and UT2. MS-R1 and MS-R2 consist of predominantly medium to coarse sand with some small gravel materials along MS3. Due to past downcutting associated with headcut migration, most grade control along the project reaches appears to be provided by existing culverted stream crossings. Much of the parent material, which contains fine/medium sand particle sizes, are mostly buried and still evident in the bank profiles. Field investigations suggest that the fine sediment supply is being recruited predominantly from streambank erosion along the project stream reaches and upland agricultural activities. The streambank erosion along the project stream reaches appears to be limited during episodic storm flows due to the lack of buffer vegetation and rotational crop cover.

3.4.5 *Jurisdictional WOTUS*

WLS investigated on-site jurisdictional waters of the US (WOTUS) using the US Army Corps of Engineers (USACE) Routine On-Site Determination Method. This method is defined in the 1987 Corps of Engineers Wetlands Delineation Manual and subsequent Atlantic and Gulf Coastal Plain Regional Supplement (USACE, 1987). Determination methods included stream classification utilizing the NCDWQ Stream Identification Form (v4.11) and the USACE Stream Quality Assessment Worksheet. Potential jurisdictional (JD) wetland areas were classified using the USACE Wetland Determination Data Form. Field evaluations conducted by WLS indicated that all Project reaches were classified as jurisdictional stream channels. In addition, one jurisdictional wetland area (totaling 0.35 acres) was delineated within the Project area (Figure 6 and Appendix 9).

WLS submitted a preliminary jurisdictional determination (PJD) application package to the USACE in December 2019 and a USACE/DWR site visit was held on February 6th, 2020. Anthony Scarbraugh with DWR and Emily Thompson and Kyle Barnes with the USACE attended the site visit. The final PJD was issued on March 27th, 2020 and provided in Appendix 9. USACE and DWR classified project reaches MS2 and MS3 as perennial, MS1 and UT1 as intermittent, and UT2 as ephemeral. During the PJD site visit, WLS and USACE/DWR representatives visited the ‘south reference reach’ site to compare existing site conditions. After observing the adjacent headwater stream reference reach and reviewing the pre-restoration monitoring flow gauge data and geomorphic survey data (See Figure 11 Reference Reach Map and Appendix 2), both the USACE and DWR representatives agreed with the headwater steam restoration approach for reaches UT1 and UT2 and recommended installing an additional flow gauge along UT2 to document surface flow before and after restoration activities.

Accordingly, WLS will collect pre-and post-restoration data for reaches UT1 and UT2 to document surface flow hydrology and headwater stream channel characteristics to support the jurisdictional determination and regulatory requirements. The PJD and flow data will be provided in the final mitigation plan and issued with the NWP 27. The 30 days minimum flow requirement was also discussed during the NCIRT post-contract site visit held on June 15th, 2018 as documented in the meeting minutes (See Appendix 12).

Drained hydric soils are located in the floodplain areas throughout the project area. After restoration activities, these areas will experience improved wetland hydrology and headwater stream flow regime. Existing stream profiles will be elevated and local water table conditions adjacent to the channels will increase flooding of riparian wetland areas. The proposed stream and wetland impacts are considered temporary and will be included with the 401/404 permit application.

3.5 Potential Site Constraints

3.5.1 *Existing Easements and Right-Of-Ways on the Site*

There are no existing easements or right-of ways within the Site.

3.5.2 *Utility Corridors within the Site*

There are no existing utility corridors within the Site.

3.5.3 *Mineral or Water Rights Assurance*

There are no mineral or water rights issues within or adjacent to the Project properties.

3.5.4 *Hydrologic Trespass*

None of the Project reaches are located within a FEMA regulated floodplain. While it is not anticipated that there will be issues associated with FEMA permitting or documentation, WLS will coordinate with the local floodplain administrator as needed and prepare the required documentation to obtain approval for any FEMA regulated impacts. In addition, the Project will be designed so that any increase in flooding will be contained within the Project boundary and will not impact adjacent landowners; therefore, hydrologic trespass will not be a concern.

3.5.5 *Conditions Affecting Hydrology*

As discussed previously in Section 3.4.1, there are several existing ditches throughout the Project area. These ditches were historically used to drain fields and create arable land for farming practices. During construction, some these ditches will be plugged and graded to restore the natural topography to prevent them from negatively affecting hydrology. For estimation purposes, the lateral ditch method developed by Skaggs was used to calculate the distance that these ditches influence hydrology through drained hydric soil areas (Skaggs, 2005). The distance of influence is defined as the width of a strip adjacent to the ditch that is drained such that it will no longer satisfy the adjacent wetland hydrologic criterion. The method uses inputs of ditch depth, depth to impermeable layer, effective hydraulic conductivity, drainable porosity, T25, and the nondimensional solution to the Boussinesq equation to calculate the lateral effect. Simulation analyses were conducted using DRAINMOD (Skaggs, 2012) to define the minimum drainage intensity required to satisfy a minimum 14-day wetland hydroperiod across the primary ditch networks. Analyses included the hydric soils properties and hydraulic conductivities referenced in the soils report and as published by NRCS. The method predicted a lateral effect of 175 ft, 162 ft and 174 ft for existing ditches along MS, UT1 and UT2 respectively. The lateral drainage ditch summary outputs are in Appendix B.

3.5.6 *Invasive Species Vegetation*

Chinese privet and Multiflora rose were observed within the existing riparian buffer area along MS3. These areas will be monitored by WLS, and any invasive plants found within the Project boundary will be treated to prevent expansion and establishment of a substantial invasive community.

3.5.7 *Future Potential Site Risks and Uncertainties*

Future potential site risks include, but are not limited to adjacent development, silviculture, drainage ditch maintenance, and beaver recruitment. Many of these potential risks may be unavoidable, however, project reaches are designed to be self-maintaining and resilient in a dynamic landscape. Riparian buffers in excess of 50 feet will protect the project streams and wetlands from changes in watershed hydrologic regimes. Any beaver activity will be continuously monitored and appropriate remedial action will be taken to discourage beaver recruitment and negative impacts to site hydrology.

3.6 Existing Wetland Conditions

As described in Section 3.4.1, on-site streams were manipulated and/or deepened, and groundwater elevations were lowered such that many of the historic riparian wetlands along the floodplain have been drained and lost. These areas have been utilized for agricultural production over the past few decades and have lost their historic wetland function. The headwater stream valleys and associated floodplains are mapped as hydric soils and have a presence of sand and loam. As a result of past ditching activities and subsequent groundwater and hydrology impacts, these areas are not currently considered jurisdictional wetlands.

NC WAM: WLS completed wetland evaluations of the Project wetlands using the *NC Wetland Assessment Method* (NC WAM, Version 5, 2016) developed by the NC Wetland Functional Assessment Team (WFAT). The purpose of NC WAM is to provide the public and private sectors with an accurate, consistent, rapid, observational, and science-based field method to determine the level of function of wetlands within North Carolina. NC WAM can be used as a tool for the consideration of project restoration design and planning, allowing for impacts to be avoided and/or minimized, and to provide information concerning assessed wetland characteristics and functions for the regulatory review process.

WLS evaluated the NC WAM metrics relevant to the project wetland located at an existing in-line agricultural BMP, as shown in Appendix 8. The metrics were documented to evaluate various wetland functions. The Project wetland WA scored 'low' due to altered hydrologic connectivity, water quality, and habitat. These ecological assessments incorporated qualitative and quantitative observations using historic aerials, field evaluations, and detailed topographic survey data collected across the site. The conclusions from these assessments help describe the current wetland ecological conditions and functional ratings, however, these methods are not intended to be used for determining mitigation success on constructed stream and wetland sites.

4 Functional Uplift Potential

Harman et al. (2012) provides a framework for conducting function-based assessments to develop project goals and objectives based on a site's restoration potential and functional uplift. The framework is based on the Stream Functions Pyramid (SFP) which is a conceptual model that can be used to better define project goals and objectives by linking them to stream functions. Stream functions are separated into a hierarchy of functions and structural measures, ranging from Level 1 to Level 5 and include the following functional categories: Hydrology (Level 1), Hydraulic (Level 2), Geomorphic (Level 3), Physiochemical (Level 4), and Biological (Level 5). Chapter 4 of *A Function-Based Framework* (Harman et al., 2012) provides a more detailed description of the SFP and is illustrated in Appendix 2. The SFP framework is applied below to further describe the functional lift potential based on the existing conditions assessment and proposed restoration design elements.

4.1.1 Function-Based Parameters and Measurement Methods

Function-based parameters and measurement methods were evaluated using the NC Stream Functional Lift Quantification Tool (SQT, v3.0) to help assess the existing stream conditions, determine restoration potential and identify risks associated with the project site. The SQT is a qualitative and quantitative resource used to describe the function-based condition of each project reach, as well as evaluate functional capacity and predict the overall proposed lift (Harman and Jones, 2016). WLS applied the SQT to help further define goals and objectives based on the restoration potential. The results of this assessment helped determine the highest level of restoration that may be achieved based on-site constraints and existing conditions. Table 9 shows the function-based condition assessment parameters and measurement methods selected to help quantify and describe each functional category. The complete SQT functional assessment worksheets and summaries are provided in Appendix 2.

Table 9. Existing and Proposed Functional Condition Assessment Summary

Functional Category (Level)	Function-Based Parameters	Measurement Method
Hydrology (Level 1)	Catchment Hydrology	Catchment Assessment/ Curve Number
	Runoff	Curve Number
Hydraulics (Level 2)	Floodplain Connectivity	Bank Height Ratio
		Entrenchment Ratio
Geomorphology (Level 3)	Bank Migration/Lateral Stability	Meander Width Ratio
		Percent Streambank Erosion
	Riparian Vegetation	Left Buffer Width (ft)
		Right Buffer Width (ft)
	Bed Form Diversity	Pool Depth and Spacing Ratio
		Percent Riffle and Pool
	Sinuosity	Planform
	Channel Evolution	Simon Channel Evolution Model

Note 1: Table adapted from Harman et al. (2012).

Note 2: Level 4 and Level 5 Parameters were not evaluated and post-restoration monitoring activities will not be tied to performance standards nor required to demonstrate success for credit release.

4.1.2 Performance Standards and Functional Capacity

The Pyramid Framework includes performance standards associated with the function-based assessments and measurement methods described above. The performance standards are used to determine the functional capacity and are stratified into three types: *Functioning (F)*, *Functioning-at-Risk (FAR)*, and *Not Functioning (NF)*. The detailed definitions and index value ranges for each type are described further in the SQT (Harman and Jones, 2016). Table 10 summarizes the overall reach scoring and functional lift summary for each project reach.

Table 10. Functional Lift Scoring Summary

Project Reach Designation	Functional Lift Score (PCS-ECS)	Functional Lift (%)	Overall Existing vs. Proposed Condition
MS1	0.32	229	NF / F
MS2	0.32	231	NF / FAR
MS3	0.32	258	NF / FAR

4.1.3 Restoration Potential

After completing the function-based assessment, the restoration potential was determined to better define the Project design goals and objectives. It is common for restoration projects to occur at a reach scale that provide minimum functional lift of Level 2 and 3 parameters. However, to achieve goals in Levels

4 and 5, a combination of reach scale restoration and upstream watershed health must be measurable and sustainable. The overall restoration potential was determined at Level 3 (Geomorphology) since the watershed assessment scored 'Fair' and may not fully support biological reference conditions in some of the project reaches given the nutrient inputs, smaller headwater drainages, intermittent flows, and watershed conditions. It should be noted that the SQT (version 3.0) does not consider headwater stream classification (Rosgen 'DA' stream type) and therefore not included in the functional lift scoring summary. However, it is expected that the implementation of this project will reduce pollutant loads, including sediment and nutrients, improving overall aquatic functions.

The SQT manual recommends that practitioners, stakeholders and regulators collaborate when selecting appropriate parameters for determining whether project goals and objectives are being met or if any performance standards need to be adjusted based on local site conditions. Not all functional categories and parameters and performance standards listed in the SQT will be compared or required to determine project success and stream mitigation credit and debit scenarios. However, selecting applicable monitoring and evaluation methods will help develop a more function-based assessment and improve our project implementation process, thereby advancing the practice of ecosystem restoration.

5 Mitigation Project Goals and Objectives

WLS developed mitigation project goals and objectives to provide compensatory mitigation credits to DMS based on the existing conditions, functional capacity and restoration potential to improve and protect diverse aquatic resources comparable to stable stream and wetland systems within the Coastal Plain Physiographic Province. The Project will provide numerous water quality and ecological benefits within the Southwest Creek Watershed, which drains to the Neuse River. While many of these benefits are focused on the project area, others, such as nutrient removal, sediment reduction, and improved aquatic and terrestrial habitat, have more far-reaching effects extending downstream to the Neuse River. The project will meet the general restoration and protection goals outlined in the 2010 (amended 2018) Neuse River Basin Restoration Priority Plan (RBRP). More specifically, the functional goals and objectives outlined in the RBRP will be met by:

- Reducing sediment and nutrient inputs to the Southwest Creek Watershed.
- Restoring and protecting streams, wetlands, riparian buffers and aquatic habitat.
- Implementing agricultural BMPs and stream restoration in nutrient sensitive watersheds.

To accomplish these project-specific goals, the following objectives will be measured to document overall project success:

- Restore stream and floodplain interaction and geomorphically stable conditions by reconnecting historic flow paths and promoting more natural flood processes;
- Improve and protect water quality by reducing streambank erosion, nutrient and sediment inputs;
- Restore and protect riparian buffer functions and habitat connectivity in perpetuity by recording a permanent conservation easement; and
- Incorporate water quality improvement features to reduce nonpoint source inputs to receiving waters.

Function-based goals and objectives were considered that relate restoration activities to the appropriate parameters from the SFP framework, which are based on existing conditions, site constraints and overall restoration potential. When developing realistic function-based project goals and design objectives, it is imperative to know why the functions or resources need to be restored (Goal) and what specific restoration activities and measurement methods will be used to validate the predicted results (Objective). To accomplish these site-specific goals, the following function objectives will be measured to document overall project success as described in Table 11 below.

Table 11. Function-Based Goals and Design Objectives Summary

Functional Category (Level)	Functional Goal / Parameter	Functional Design Objective
Hydrology (Level 1)	Improve Base Flow	Improve existing stream crossings and restore a more natural flow regime and aquatic passage.
Hydraulics (Level 2)	Reconnect Floodplain / Increase Floodprone Area Widths	BHRs to not exceed 1.2 and increase ERs ≥ 2.2 for Rosgen 'C' and 'E' stream types and ≥1.4 for Rosgen 'B' stream types.
Geomorphology (Level 3)	Improve Bedform Diversity	Increase riffle/pool percentage and pool-to-pool spacing ratios.
	Increase Lateral Stability	Reduce BEHI/NBS streambank erosion rates comparable to downstream reference conditions.
	Establish Riparian Buffer Vegetation	Plant and protect native species vegetation a minimum 50' wide from the top of the streambanks with a composition/density comparable to reference condition.
Physicochemical (Level 4)	Improve Water Quality	Treat adjacent stormwater and agricultural runoff.
Biology (Level 5)	Improve Macroinvertebrate Community and Aquatic Species Health	Incorporate native woody debris into channel.

As described in Section 4, the function-based assessment suggests that the proposed mitigation activities will result in a higher functioning aquatic ecosystem. The project goals and objectives address water quality stressors by reducing nutrient and sediment inputs through stream restoration and incorporating water quality improvement features. Wetland hydrologic functions will be also be improved by raising the local water table, especially around reaches MS2 and M3.

A more natural flow regime will be restored to floodplain and an existing wetland area by implementing a Priority Level I Restoration. The biologic and habitat functions will be improved by extending wildlife corridors that connect with wooded areas near the downstream extents of the project area. Additionally, site protection through a conservation easement in excess of 50 feet from the top of banks, will protect all stream reaches and aquatic resources in perpetuity. These mitigation efforts will provide a significant ecological benefit with minimal impacts and constraints during a recovery period that would not otherwise occur through natural processes.

5.1.1 Project Benefits Summary

The project will provide numerous water quality and ecological benefits within the Southwest Creek Watershed. While many of these benefits will focus on the project area, others, such as nutrient removal, sediment reduction, and improved aquatic and terrestrial habitat, others have more far-reaching effects that extend downstream. The expected project benefits and ecological improvements are summarized below in Table 12.

Table 12. Project Benefits Summary

Benefits Related to Hydrology	
Rainfall/Runoff	Improving existing stream crossings and properly sizing pipe culverts and water quality treatment features will reestablish more natural flow conditions and water transport during various storm events.
Benefits Related to Hydraulics	
Floodplain Connectivity	The restored streams will be raised and reconnected to their active or relic floodplains to spread higher flow energies onto the floodplain thereby increasing retention time and floodplain roughness.
Surface Storage and Retention	Incorporation of vernal pools, depressional areas, and other constructed floodplain features will improve flow dynamics by reducing runoff velocities and provide additional surface storage and habitat diversity.
Groundwater Recharge/ Hyporheic exchange	Benefits will be achieved through protecting vegetated buffers, which increase groundwater infiltration, surface water interaction, and recharge rates.
Benefits Related to Geomorphology	
Proper Channel Form	Restoring an appropriate dimension, pattern, and profile will efficiently transport and deposit sediment (point bars and floodplain sinks) relative to the stream's power and load that is supplied from banks and uplands. Stream channels that are appropriately sized to convey higher frequency storm flows will greatly improve channel stability by reducing active bank erosion (lateral stability) and bed degradation (vertical stability; i.e. headcuts, downcutting, incision).
Sediment Transport	Boundary conditions, climate, and geologic controls influence stream channel formation and how sediment is transported through its watershed. Adequate channel capacity will ensure sediment supply is distributed such that excessive degradation and aggradation does not occur.
Riparian Buffer Vegetation	Protecting buffer vegetation will improve thermal regulation (stream shading) along the riparian corridor, as well as increase woody root mass and density thereby decreasing bank erosion and sedimentation and increasing organic matter and woody debris.
Bioengineering Treatments	Bioengineering practices such as live staking, brush layering, and vegetated soil lifts will help encourage lateral bank stability and prevent further bank erosion and sedimentation.
Benefits Related to Physicochemical (Water Quality)	
Nutrient Reduction	Benefit will be achieved through water quality treatment features, filtration and nutrient uptake within the restored and enhanced floodplain, wetlands, and vegetated buffers.

(Table 12 continued)

Sediment Reduction	Benefit will be achieved through stabilization of eroding banks; installation of vegetation buffers; and by dissipating stream energy with increased overbank flows during storm events.
DO, NO_3^-, DOC Concentration	Benefits will be achieved through the restoration of more natural stream forms including riffle and pool sequences, which will increase dissolved oxygen (DO) concentrations. In addition, protecting riparian buffers will increase shade and reduce water temperatures and groundwater nitrates (NO_3^-) as well as increase dissolved organic carbon (DOC) (King et al, 2016).
Benefits Related to Biology	
Terrestrial and Aquatic Habitat	Benefits will be achieved through the incorporation of physical structure, removal of invasive species vegetation and returning native vegetation to the restored/enhance buffer areas. Benefits to aquatic organisms will be achieved through the installation of appropriate in-stream structures. Adequately transporting and depositing fine-grain sediment onto the floodplain will prevent embeddedness and create interstitial habitat, organic food resources and in-stream cover.
Landscape Connectivity	Benefits to landscape connectivity will be achieved by restoring a healthy stream corridor, promoting aquatic and terrestrial species migration and protecting their shared resources in perpetuity.

6 Design Approach and Mitigation Work Plan

The project includes the restoration of five stream reaches (MS1, MS2, MS3, UT1, and UT2) totaling approximately 5,151 linear feet of stream channels (See Figure 9). The design approach will utilize a Priority Level I Restoration and headwater valley restoration approach that appropriately addresses all stream reaches at the project site, thus providing the maximum functional uplift. The mitigation components and proposed credit structure is outlined in Table 13 and the design approach and mitigation work plan are described in the following subsections.

Table 13. Mitigation Components and Proposed Credit Summary

Project Segment	Existing Footage or Acreage	Mitigation Plan Footage or Acreage	Mitigation Category	Restoration Level	Priority Level	Mitigation Ratio (X:1)		As-Built Footage or Acreage	Comments
MS1	1,493	1,440	Warm	R	PI/PII	1.00			Full Channel Restoration, Planted Buffer, Permanent Conservation Easement
MS2	774	943	Warm	R	PI	1.00			Full Channel Restoration, Planted Buffer, Permanent Conservation Easement
MS3	1,548	1,529	Warm	R	PI/PII	1.00			Full Channel Restoration, Planted Buffer, Permanent Conservation Easement
UT1	498	677	Warm	R	PI/HW	1.00			Full Channel Restoration, Planted Buffer, Permanent Conservation Easement
UT2	644	562	Warm	R	PI/HW	1.00			Full Channel Restoration, Planted Buffer, Permanent Conservation Easement

Project Credits

Restoration Level	Stream			Riparian Wetland		Non-Rip	Coastal
	Warm	Cool	Cold	Riverine	Non-Riv	Wetland	Marsh
Restoration	**5151.000**						
Re-establishment							
Rehabilitation							
Enhancement							
Enhancement I							
Enhancement II							
Creation							
Preservation							
Totals	**5151.000**			**0.000**	**0.000**	**0.000**	

6.1 Stream Design Approach

As described above in Sections 4 and 5, WLS used function-based assessment methods and data analyses to determine overall restoration potential and functional uplift. The stream design approach generally followed the techniques and methods outlined in the *NRCS Stream Restoration Design–National Engineering Handbook* (NRCS, 2007) and *Hydraulic Design of Stream Restoration Projects* (USACE, 2001). In addition, the natural stable channel design (NCD) procedures outlined in the *Natural Channel Design Review Checklist* (Harman and Starr, 2011) were applied to address specific stream functions lost across the site, while also minimizing disturbances to existing wooded areas and higher functioning resources.

WLS first compiled and assessed watershed information such as drainage areas, historic land use, geologic setting, soil types, sediment inputs and existing plant communities. LDSI, Inc. then performed detailed existing conditions topographic and planimetric surveying of the project site and produced a 1-foot contour map, based on survey data, to create base mapping and plan sheets (See Appendix 1). Detailed geomorphic surveys were also conducted along the channel and floodplain to determine valley slopes/widths, channel dimensions, longitudinal profile elevations, and to validate the signatures shown on the LiDAR imagery (See Figure 5).

Project stream design criteria was developed using a combination of industry sources and applied approaches, including a review of applicable reference reach data (analog), evaluation of published regression equations and hydraulic geometry relationships (regional curves), monitoring results from stable past projects (empirical), and building a hydraulic model using process-based equations (HEC-RAS) to test design channel geometry and bed stability (analytical). It should be mentioned, while analog and empirical form-based approaches have been proven effective in designing stable stream systems, their application assumes quasi-equilibrium conditions and similar watershed and boundary conditions (i.e. dominant discharge, flow regime, channel roughness, controlling vegetation). Using a static design template that accounts for natural channel variability can be limited by the regional data sets and overlook other local controlling factors such as flow impoundments, bedrock geology, woody debris/abundance, and sediment supply (Skidmore, 2001).

Conversely, analytical or process-based approaches rely heavily upon precise data inputs and a more robust level of effort may not be practical or even necessary to replicate channel geometry given the model sensitivity and desired outcome. Designing dynamic natural channels is an iterative process that requires a detailed assessment of sediment continuity and predicted channel response for a range of smaller flows. Although it is difficult to definitively predict long term hydrologic conditions in the watershed, designing an appropriate stream channel for the valley characteristics (i.e. slope, width, and confinement) is always the preferred design rationale. Therefore, best professional judgment must be used when selecting appropriate design criteria for lifting the desired ecological functions.

6.1.1 Proposed Design Parameters

The proposed design parameters describe the planimetric, cross-section dimensions, and longitudinal profiles as illustrated on the construction documents. The design philosophy considers these parameters as conservative guidelines that allow for natural variability in stream dimension, facet slopes, and bed features to form by the processes of flooding, vegetation establishment, and other watershed influences (Harman, Starr, 2011). The design parameters for the project reaches are based on reference reach data, monitoring data, and conclusions developed from an analysis of functional riparian headwater stream systems in the Coastal Plain setting. This analysis evaluated the conditions that determine channel formation in headwater systems, and developed relationships between drainage area and valley slope that correlate to channel form. The information gathered from this study can be used to help predict if a natural stream system will maintain form as a single or multiple-thread channel (Tweedy, 2009). Under stable conditions (dynamic equilibrium), these multi-thread stream systems are classified as Rosgen 'DA' stream types (Rosgen, 1996). Nanson and Knighton characterized anastomosed channels by having low gradients and low stream power ($\leq 10\ Wm^{-2}$). These flow regimes are often more aggradational, have channel slopes flatter than 0.01 ft/ft, width/depth ratios higher than 20, however channel sinuosity or "transitional patterns" can vary greatly from 1.1 to 1.5 (Nanson and Knighton, 1993).

A headwater valley restoration approach is proposed for UT1 and UT2 due to their smaller drainage areas and flatter slopes. It is likely that prior to disturbed conditions, these systems existed as lower gradient headwater stream and wetland complexes within the natural valley, exhibiting moderately defined channels with diffuse flow paths and increased meander lengths before transitioning towards a more well-defined channel with increased sinuosity's and bed and bank formations. This restoration approach is supported by on-site hydric soils investigation, surface flow observations, topography, and comparing extensive reference site data. Hydric soils are mapped along the riparian corridors of the proposed stream reaches. These shallow drainage ways are commonly observed in this area and typically support headwater stream channels and wetland plant communities.

WLS has implemented numerous successful projects in ungaged headwater drainages in the Coastal Plain hydrophysiographic province of North Carolina. As noted above, monitoring data from these restoration projects and reference information were evaluated and added to the original dataset as a comparison (see channel form comparison in Appendix 2). These data indicate that geomorphic conditions for the project reaches prior to anthropogenic disturbance (ditching and agriculture), would have likely supported a moderately defined headwater stream (with variable channel geometry and valley bottom widths), but highly sinuous (K>1.5) well-defined single-thread meandering channels may not be entirely appropriate. Providing additional data points for comparison through reference site surveys and literature research also help develop these linear relationships. The data set on these small stream curves help reduce uncertainty by providing additional reference points and supporting evidence for the selection of bankfull indicators that produce slightly smaller dimensions and flow rates than the published regional curve data set.

Table 14. Proposed Design Parameters

Parameter	MS1	MS2	MS3	UT1	UT2
Drainage Area, DA (sq mi)	0.286	0.347	0.517	0.071	0.050
Stream Type (Rosgen)	DA/E5	C5/E5	C5/E5	DA	DA
Bankfull Riffle XSEC Area, Abkf (sq ft)	3.7	4.3	5.4	1.2	1.2
Bankfull Mean Velocity, Vbkf (ft/sec)	1.1	1.0	1.2	1.2	1.0
Bankfull Riffle Width, Wbkf (ft)	6.9	7.5	8.4	4.4	4.4
Bankfull Riffle Mean Depth, Dbkf (ft)	0.5	0.6	0.6	0.3	0.3
Width to Depth Ratio, W/D (ft/ft)	13.0	13.0	13.0	16.0	16.0
Width Floodprone Area, Wfpa (ft)	15 – 30	29 - 47	19 – 30	15 – 30	15 – 30
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	2.2 – 4.3	3.9 – 6.3	2.3 – 3.6	3.4 – 6.8	3.4 – 6.8
Riffle Max Depth Ratio, Dmax/Dbkf	1.1 – 1.4	1.1 – 1.4	1.1 – 1.4	1.2	1.2
Bank Height Ratio, Dtob/Dmax (ft/ft)	1.0 – 1.1	1.0 – 1.1	1.0 – 1.1	1.0 – 1.1	1.0 – 1.1
Meander Length Ratio, Lm/Wbkf	N/A	7.1 – 13.1	7.2 – 13.1	N/A	N/A
Radius of Curvature Ratio, Rc/Wbkf	N/A	2.0 – 3.1	2.0 – 3.0	N/A	N/A
Meander Width Ratio, Wblt/Wbkf	N/A	3.6 – 6.4	3.5 – 7.4	N/A	N/A
Channel Sinuosity, K	~1.02	~1.11	~1.18	~1.09	~1.07
Channel Slope, Schan (ft/ft)	0.0049	0.0037	0.0044	0.0092	0.0065
Riffle Slope Ratio, Sriff/Schan	0.8 – 1.7	0.8 – 1.6	1.1 – 1.5	0.4 – 1.4	0.4 – 1.5
Pool Slope Ratio, Spool/Schan	0.0 – 0.2	0.0 – 0.2	0.0 – 0.3	0.0 – 0.2	0.0 – 0.2
Pool Width Ratio, Wpool/Wbkf	1.2 – 1.5	1.2 – 1.5	1.2 – 1.5	1.3 – 1.7	1.3 – 1.7
Pool-Pool Spacing Ratio, Lps/Wbkf	4.3 – 7.2	3.9 – 7.1	4.2 – 7.0	4.6 – 11.4	4.6 – 11.4
Pool Max Depth Ratio, Dmaxpool/Dbkf	2.2 – 3.4	1.7 – 2.8	2.3 – 3.3	1.8 – 3.3	1.8 – 3.3

6.1.2 Design Reach Summary

For design purposes, the stream segments were divided into multiple reaches labeled MS1, MS2, MS3, UT1, and UT2 as shown in Figure 9. The design approach will provide a stable channel form with appropriate bedform diversity, as well as improved ecological function through increased aquatic and terrestrial habitats. It is anticipated that the design width/depth ratios for the restored channels will be similar to stable streams in this geologic setting. In-stream structures, such as constructed wood riffles, log step-pools, log vanes and log weirs will be used to dissipate flow energy, protect streambanks, prevent future incision, provide aquatic habitat, and increase bedform diversity. Restored streambanks will be graded to stable side slopes and the floodplain will be reconnected to further promote stability and hydrological function. Bioengineering techniques, such as geolifts, toe wood, and live stakes, will also be used to protect streambanks and promote woody vegetation growth along the streambanks.

Riparian buffers in excess of 50 feet will be improved and/or protected along all the project reaches. Any mature trees or significant native vegetation will be protected and incorporated into the design. The existing unstable channels will be filled to an elevation sufficient to connect the new bankfull channel to its historic floodplain, or an excavated floodplain will be constructed, using suitable fill material from the newly restored channel and remnant spoil piles. Any exotic species vegetation will be removed, and native riparian species vegetation will be replanted in the resulting disturbed areas. The following narrative summarizes the proposed design approach, rationale and justification for each of stream reaches.

Restoration: MS1, MS2, MS3, UT1, UT2

MS1: MS1 is a headwater tributary that has been channelized and straightened along its entire length. The upstream area of MS1 drains a ditch network that appears to have been dug through historic non-riparian wetlands. The channelization has disrupted the historic flow and natural flooding patterns across the site. The upper portion of MS1 is steeper and more confined. Along the upper section of MS1, work will begin as a Priority Level II/III Restoration by gradually raising the bed elevation and excavating a floodplain bench before reconnecting the stream with its geomorphic floodplain (Priority Level I), which will promote more frequent over bank flooding. The valley bottom will be graded to restore the natural microtopographic variability that is common within headwater systems. A shallow flow path will be constructed to form a small pilot channel and the base flow will be allowed to follow historic flow patterns and spread out through channel depressions, restoring a more natural hydrology function.

MS2: The restoration of MS2 will continue below MS1 as the valley turns to the southwest. Along this section of MS2, work will transition to Priority Level I Restoration by raising the bed elevation and reconnecting the stream with its relic floodplain, which will promote more frequent over bank flooding. A stable stream system will be achieved by constructing a single-thread meandering channel across the floodplain. Proposed grading activities will restore historic flow patterns and improve wetland hydrology by removing berms and other agricultural land manipulations. The reach will be restored using appropriate riffle-pool morphology with a conservative meander planform geometry that accommodates the valley slope and width. As MS2 flattens along its lower half and flows into the existing in-line agricultural BMP, the current channelized stream will be graded to the natural valley topography prior to the backwater condition. The existing stream crossing will be improved at the same location near the downstream end of MS2. At the proposed permanent stream crossing, the failing/perched pipe culvert will be replaced to improve aquatic passage channel and the existing channel will be filled slightly to an elevation sufficient to connect the channel to its historic floodplain using native woody material and suitable fill material from overburden areas.

MS3: MS3 begins near the existing woodline near the confluence of UT2 and MS2. MS3 is actively downcutting and the incised channel has been historically manipulated. Work along MS3 will continue as a Priority Level I Restoration by raising the bed elevation and reconnecting the stream with its geomorphic floodplain to promote more frequent over bank flooding. A stable stream will be achieved by constructing a single-thread meandering channel across the geomorphic floodplain before gradually lowering the stream bed elevation near the existing road crossing. Proposed grading activities will restore historic flow patterns and adjacent wetland hydrology by removing berms and other agricultural land manipulations. The lower section of MS3 will transition to a Priority Level II Restoration by gradually lowering the bed elevation and excavating a floodplain bench before reconnecting the stream with the existing bed elevation prior to flowing into an existing culvert crossing. The reach will be restored using appropriate riffle-pool morphology with a conservative meander planform geometry that accommodates the valley slope and width. Any exotic species vegetation will be removed in this area and native riparian species vegetation will be replanted in the resulting disturbed areas.

UT1 and UT2: UT1 and UT2 are small headwater tributaries that have been channelized/straightened along their entire length. Prior to disturbance, these areas most likely functioned as headwater stream and wetland systems and the channels are not currently located within the historic valley/low point as shown on LiDAR mapping (Figure 5). Beginning above the upstream reaches, the ditches and channelized streams will be filled and graded to the natural valley topography prior to the pre-drained condition. The restored reaches will be relocated to the low point of the historic valley from the existing agricultural field to the wooded area as they flow towards their new confluence with MS2 and MS3. The valley bottom will be graded to restore the natural microtopographic variability that is common within headwater systems. A shallow flow path will be constructed to form a small pilot channel similar to the adjacent reference sites described in Section 6.2.1. The base flow will follow diffuse flow paths and spread out through these graded depressions, restoring a more natural hydrology function. At the lower reach locations, the headwater channels will transition into the single-thread channel and will gradually merge into a broader swale that will connect to the single-thread design bankfull width and depth. The existing channels will be filled to an elevation sufficient to connect the headwater channels to its historic floodplain using native woody material and suitable fill material from overburden areas. Riparian buffers in excess of 50 feet will be restored and protected along the entire project reaches.

6.2 Reference Sites

6.2.1 Reference Streams

The morphologic data obtained from reference reach surveys can be a valuable tool for comparison and used as a template for analog design of a stable stream in a similar valley type with similar bed material. To extract the morphological relationships observed in a stable system, dimensionless ratios are developed from the surveyed reference reach. These ratios can be applied to a stream design to allow the designer to 'mimic' the natural, stable form of the target channel type. While reference reach data can be a useful aid in analog design, they are not always necessary and can have limitations in smaller stream systems (Hey, 2006). The flow patterns and channel formation for many reference reach quality streams are often controlled by slope, bed material, drainage areas and larger trees and/or other deep-rooted vegetation. Some meander geometry parameters, such as radius of curvature, are particularly affected by vegetation control. Pattern ratios observed in reference reaches may not be applicable or are often adjusted in the design criteria to create more conservative designs that are less likely to erode after construction before the permanent vegetation is established. Often the best reference data is from adjacent stable stream reaches or reaches within the same watershed.

For comparison purposes, WLS selected local reference reaches in an adjacent watershed (See Figure 11) and compared them with composite CP reference reach data. The reference reach data set was compiled from the NC reference reach database, published by NCDOT and reference reach surveys conducted by Michael Baker Corporation (Harman, 2011). This data set provides typical reference reach ratios for stable streams in NC and can be used to compare a restoration project to the typical reference reach condition for geomorphology. The local reference reach data represents small "Coastal Plain Stream," with similar valley morphology and slopes that fall within the same climatic, hydrophysiographic and ecological region as the project site. The reference reach data shown on Table 15 helped to determine an appropriate design approach for both headwater valley (multi-thread channels) and single-thread channel restoration. Additional CP headwater stream comparisons data is provided in Appendix 2. Figure 11 shows the reference site locations as compared to the project site.

Table 15. Reference Reach Data Comparison

Parameter	Local Reference Data	Composite Reference Data
Stream Type (Rosgen)	Headwater (DA)	E5 / C5
Drainage Area (Acres)	37	---
Bankfull Mean Velocity, Vbkf (ft/s)	1.2	1.0 – 1.4
Width to Depth Ratio, W/D (ft/ft)	10.1 – 19.5	8.0 – 16.0
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	4.3 – 5.8	4.0 – 13.0
Riffle Max Depth Ratio, Dmax/Dbkf	1.5	1.2 – 1.7
Bank Height Ratio, Dtob/Dmax (ft/ft)	1.0 - 1.2	1.0 – 1.3
Meander Length Ratio, Lm/Wbkf	N/A	9.0 - 15.0
Radius of Curvature Ratio, Rc/Wbkf	N/A	1.5 – 3.0
Meander Width Ratio, Wblt/Wbkf	N/A	2.0 – 7.0
Sinuosity, K	N/A	1.2 – 1.7
Valley Slope, Sval (ft/ft)	0.0083	0.001 – 0.015
Channel Slope, Schan (ft/ft)	0.0080	0.001 – 0.020
Pool Max Depth Ratio, Dmaxpool/Dbkf	1.4 – 2.5	1.2 – 2.4
Pool Width Ratio, Wpool/Wbkf	0.9 – 1.3	0.8 – 1.4
Pool-Pool Spacing Ratio, Lps/Wbkf	4.7 – 7.9	3.5 – 7.0

Note 1: Composite reference reach data were compiled from the NC reference reach database, published by NCDOT and reference reach surveys conducted by Michael Baker Corporation as published in the Natural Channel Design Review Checklist (Harman Starr, 2011).
Note 2: Local headwater reference reach data was collected at an adjacent unnamed tributary to Hornpipe Branch named 'South Reference Reach'.

6.3 Flow Regime

Extensive research demonstrates that a wide range of flows are essential to maintain stable and high functioning habitat across ecological systems. The flow regime has been identified as the primary factor in sustaining the ecological integrity of riparian systems (Poff et al. 1997) and is a key variable in determining the abundance, distribution, and evolution of aquatic and riparian species (Schlosser 1985, Resh et al. 1988, Power et al. 1995, Doyle et al. 2005). The ecological significance of variable stream flows is more relative to flow duration, not necessarily just the flow recurrence interval. Seasonal flow variations correlate to biological relationships and habitat response. The flow conditions can generally be categorized as low flow, channel-forming flow, or flood flows, each with specific ecological significance (Postel and Richter, 2003).

A majority of stream miles (>80 percent) in North Carolina are classified as headwater streams (drainage area <3.9 mi^2), however, less than 10 percent of the 284 USGS stream gages in North Carolina are located on headwater streams (EFSAB, 2013). WLS recognizes the importance of these stream flow variables and the ecological role they play in supporting high functioning headwater steam and wetland systems. As such, flow monitoring will be conducted to demonstrate that the restored headwater stream systems exhibit seasonal base flow during a year with normal rainfall conditions. The stream surface flow documentation methods are further described in Section 8.2. Table 16 summarizes the basic flow levels and ecological roles the restoration design will provide after project implementation.

Table 16. Flow Level and Ecological Role

Low Flow (Base Flow): occurs most frequently/seasonally	-Provide year-round habitat for aquatic organisms (drying/inundation pattern) -Maintain suitable conditions for water temperature and dissolved oxygen -Provide water source for riparian plants and animals -Enable movement through stream corridor and refuge from predators -Support hyporheic functions and aquatic organisms
Channel-forming Flow: infrequent, flow duration of a few days per year	-Shape and maintain physical stream channel form -Create and maintain pools, in-stream and refuge habitat -Redistribute and sort fine and coarse sediments -Reduce encroachment of vegetation in channel and establishment of exotic species -Maintain water quality by flushing pollutants -Maintain hyporheic connection by mobilizing bed and fine material -Create in-channel bars for seed colonization of native riparian plants
Flood Flow: very infrequent, flow duration of a few days per decade or century	-Deposition of fine sediment and nutrients on floodplain -Maintain diversity, function, and health of riparian floodplain vegetation -Create streamside habitat, new channels, sloughs, and off-channel rearing habitat through lateral channel migration and avulsion -Recharge floodplain and storage processes -Recruitment of native wood and organic material into channel

6.3.1 Bankfull Stage and Discharge

Bankfull stage and its corresponding discharge are the primary variables used to develop a natural stable channel design. However, the correct identification of the bankfull stage in the field was difficult and can also be subjective (Williams, 1978; Knighton, 1988; and Johnson and Heil, 1996). Numerous definitions exist of bankfull stage and methods for its identification in the field (Wolman and Leopold, 1957; Nixon, 1959; Schumm, 1960; Kilpatrick and Barnes, 1964; and Williams, 1978). The identification of bankfull stage in the humid Southeast can be especially challenging because of dense understory vegetation and extensive channel modification and subsequent adjustments in channel morphology.

It is generally understood that bankfull stage corresponds with the discharge that fills a channel to the elevation of the active floodplain and represents a breakpoint between processes of channel formation and floodplain development. The bankfull discharge, which also corresponds with the dominant discharge or effective discharge, is the flow that moves the most sediment over time in stable alluvial channels. Field indicators include the back of point bars, significant breaks in slope, changes in vegetation, the highest scour line, or the top of the streambank (Leopold, 1994).

Upon completion of the field survey and geomorphic assessment, accurate identification of bankfull stage could not be made in the reach sections due to incised and channelized/ditched conditions. Although some field indicators were evident as discernible scour features within MS3, the reliability of the indicators was inconsistent due to the altered condition of the stream channel. For this reason, the bankfull stage and discharge were estimated using published regional curve information.

6.3.2 Regional Curve Comparison

Regional curves developed by Dunne and Leopold (1978) relate bankfull channel dimensions to drainage area and are based on the channel forming discharge theory, which states that one unique flow can yield the same channel morphology as the full range of flows. A primary purpose for developing regional curves is to aid in identifying bankfull stage and dimension in un-gaged watersheds, as well as to help predict the bankfull dimension and discharge for natural channel designs (Rosgen, 1994). Hydraulic geometry relationships are empirically derived and can be developed for a specific stream or extrapolated to a watershed in the same physiographic region with similar rainfall/runoff relationships (FISRWG, 1998).

Published bankfull regional curves are available for a range of stream types and physiographic provinces. The NC Coastal Plain Regional Curve (Sweet and Geratz, 2003) and NC State University Coastal Plain Regional Curve (Doll et al., 2003) were used for comparison when estimating bankfull discharge. The NC Coastal Plain Regional Curve and bankfull hydraulic geometry equations are shown in Table 17. It’s important to note these tributaries are classified as zero and first order streams, and generally smaller headwater streams can be poorly represented on the regional curves. Based on the WLS design staff collective experience surveying numerous small ungaged stream systems, the published NC Rural Coastal Plain Regional Curve Equations can slightly overestimate discharge and channel dimensions for smaller ungaged streams. Furthermore, estimating bankfull parameters subjectively rather than using deterministic values may encourage designers to make decisions on a range of values and beliefs that the bankfull depths must inherently be within that range (Johnson and Heil, 1996).

Table 17. North Carolina Coastal Plain Regional Curve Equations

NC Coastal Plain Regional Curve Equations EcoScience (Sweet and Geratz, 2003)		NC Coastal Plain Regional Curve Equations NCSU (Doll et al., 2003)	
$Q_{bkf} = 8.79\ A_w^{0.76}$	R^2=0.92	$Q_{bkf} = 16.56\ A_w^{0.72}$	R^2=0.90
$A_{bkf} = 9.43\ A_w^{0.74}$	R^2=0.96	$A_{bkf} = 14.52\ A_w^{0.66}$	R^2=0.88
$W_{bkf} = 9.64\ A_w^{0.38}$	R^2=0.95	$W_{bkf} = 10.97\ A_w^{0.36}$	R^2=0.87
$D_{bkf} = 0.98\ A_w^{0.36}$	R^2=0.92	$D_{bkf} = 1.29\ A_w^{0.30}$	R^2=0.74

WLS has implemented numerous projects in ungauged drainages in the Coastal Plain hydrophysiographic province of North Carolina, including nearby projects in surrounding counties. The data set for these small streams help reduce uncertainty by providing additional reference points and supporting evidence for the selection of bankfull indicators, appropriate dimensions and flow rates. Channel geometry, slope, valley setting, sediment supply, as well as information from the USGS regression and Manning's equations were all considered during field data evaluation. The estimated bankfull discharges and surveyed cross-sectional areas at the top of bank were plotted on the NC Coastal Plain Regional Curve and illustrated in Appendix 2.

6.3.3 Channel Forming Discharge

A hydrologic analysis was completed to estimate and validate the design discharge and channel geometry required to provide more frequent overbank flows and floodplain inundation. WLS used multiple methods for evaluating the bankfull stage and dominant discharge for the project reaches. Cross-sections were identified and surveyed to represent reach-wide conditions. Additional bankfull estimation methods, such as the commonly accepted Manning's equation, were compared to help interpret and adjust field observations to select the appropriate design criteria and justification for the design approach.

The bankfull flows in gaged watersheds within the NC Rural Coastal Plain study documented return intervals (RI) that range from <1.0 to 1.3, with a mean of 1.2 years (Sweet and Geratz, 2003). WLS then compared lower flow frequencies in the 1.2-year RI range versus survey data, field measurements, for the design discharge analysis (See Appendix 2). It should be noted that this best fit approach does not always match the dataset, since it falls at the low end of the curve. Therefore, caution should be used when comparing these lower RIs with additional data sets. Using the rationale described above, the bankfull discharge analyses compared NC Coastal Plain regional curves, Manning's equation discharges calculated from the representative cross-section geometry and USGS regional regression equations.

Table 18. Design Discharge Analysis Summary

Project Reach Designation	Watershed Drainage Area (Ac)	EcoScience NC CP Regional Curve (cfs) [1]	NCSU NC CP Regional Curve (cfs) [2]	Manning's Equation (cfs) [3]	USGS Regression Equation for 1.2-year Recurrence Interval (cfs) [4]	Design Discharge Estimate (cfs)
MS1	183	3.4	6.7	5.1	2.9	4.0
MS2	222	3.9	7.7	5.2	3.3	4.5
MS3	331	5.3	10.3	7.6	4.1	6.6
UT1	46	1.2	2.4	2.5	1.2	1.4
UT2	32	0.9	1.9	2.2	1.1	1.2

Note 1: Published NC Coastal Plain Regional Curve (Sweet and Geratz, 2003).
Note 2: Published NC Coastal Plain Regional Curve (NCSU, 2003).
Note 3: Bankfull discharge estimates vary based on Manning's Equation for the representative riffle cross-sections. Bankfull stage roughness estimates (n-values) ranged from approximately 0.035 to 0.06 based on channel slopes, depth, bed material size, and vegetation influence.
Note 4: NC USGS rural regression equation extrapolated for 1.2-year flood recurrence interval (USGS, 2011)

After considering these estimation methods and analysis results (geometry measurements, regional curves, flow frequency and USGS regional regression equations), WLS estimated the design discharge using values near the published NC Coastal Regional Curve to select the appropriate design dimensions and flows rates that best correspond to the design channel that will convey the 1.2-yr RI.

6.3.4 Channel Stability and Sediment Transport Analysis

To evaluate channel stability and sediment transport relationships; shear stress, stream power, and width-to-depth (W/D) values were plotted against comparable Coastal Plain sand-bed reference stream data. (See Appendix 2). The design shear stress and stream power values plot within the scatter of data points collected from multiple stable Coastal Plain reference reaches. This analysis provides a basic relationship that the shear stresses and stream power predicted for the design channels are within the range of stable values. Therefore, excessive scour of the design channel is not expected once the vegetation becomes established and W/D decreases. Alluvial sand bed channels in small Coastal Plain headwater stream systems typically have a relatively low sediment supply with finer grained material (D_{50} < 2mm), therefore a more complex sediment budget or rating curve is not necessary.

Sediment transport analyses as described above were not applied to the headwater design reaches MS1, UT1 and UT2. The design for these headwater reaches involve the construction of a broad/shallow flow path along the valley bottom the system to form as a small pilot channel. Under natural stable conditions, sediment deposits in these headwater stream systems are more aggradational, due to low flow velocities and scour stresses. Furthermore, sediment supply is limited, such that over time, these systems will remain stable and deposited sediment and sorting encourages formation. For this reason, excessive scour or aggradation of the design channel is not anticipated, however, if necessary additional sediment transport calculations and stream power analyses utilizing HEC-RAS may be performed for the existing channels as compared to the final design channel geometry.

As a design consideration, the proposed design riffle slopes greater than 0.001 ft/ft will be constructed in transitional areas using wood material to provide additional grade control and bed stability. Any concerns regarding channel degradation and stability will be addressed by installing a combination of grade control structures, such as constructed log riffles and step-pools in the straighter channel segments (vertical stability) and brush toe and bioengineering in meander bends (lateral stability). In addition, improving the existing stream crossings and restoring a more natural flow regime will facilitate positive adjustments to sediment routing and storage across the reconnected floodplains. Table 19 represents the boundary shear stress and stream power values under proposed design conditions for Project reaches MS2 and MS3.

Table 19. Bankfull Shear Stress and Stream Power

Project Reach Designation	Watershed Drainage Area (Ac)	Bankfull Discharge (Q) (cfs) 2	Bankfull Velocity (ft/sec)	Bankfull Shear Stress (lbs/ft^2)	Bankfull Stream Power (W/m^2)
MS2	222	4.5	1.06	0.120	2.15
MS3	331	6.6	1.21	0.151	3.09

Note 1:Manning's Equation was calculated for the representative riffle cross-sections. Predicted roughness estimates (n-value = 0.05) was based on channel slopes, depth, sand bed material, and vegetation influence.
Note 2: Boundary shear stress and stream power for headwater reaches are not included in this table.

6.4 Riparian Buffer Design Approach

The riparian buffer plantings will be established along streambanks, floodplain and transitional uplands (fringe areas) as well as permanently protecting those buffers with a conservation easement. For the Project stream reaches proposed for restoration, the riparian buffers will be restored through reforestation. Many of the proposed riparian buffer widths within the conservation easement will be greater than 50 feet along both streambanks to provide additional functional uplift potential. The conservation easement areas also may include areas outside of the riparian buffer zone that will be revegetated, including areas that lack vegetation species diversity, or areas otherwise disturbed or adversely impacted by construction.

Proposed plantings will be conducted using native tree and shrub species, in the form of live stakes and seedlings. Proposed plantings will predominantly consist of bare root vegetation and will generally be planted at a total target density of approximately 680 stems per acre. This planting density has proven successful with the reforestation of past completed mitigation projects, based on successful regulatory project closeout, and including the current USACE regulatory guidelines requiring levels of woody stem survival throughout the monitoring period, with a Year 7 final survival rate of 210 stems per acre. In addition, this planting density is intended to also satisfy the final performance standard for generating riparian buffer mitigation credits within riparian buffer restoration and enhancement areas, which is the survival rate of 260 stems per acre at the completion of Year 5 Monitoring.

The Project planting strategy also includes early successional, as well as climax species. The vegetation selections will be mixed throughout the Project planting areas so that the early successional species will give way to climax species as they mature over time. The understory and shrub layer species are all considered to be climax species in the riparian buffer community. The total planting area is estimated to be 13.2 acres and will vary based on site conditions are areas disturbed during construction.

6.4.1 Proposed Vegetation Planting

The proposed plant selection will help to establish a natural vegetation community that will include appropriate strata (canopy, understory, shrub, and herbaceous species) based on an appropriate reference community. Schafale's (2012) guidance on vegetation communities for Coastal Plain Small Stream Swamp, the USACE Wetland Research Program (WRP) Technical Note VN-RS-4.1 (USACE, 1997), as well as existing mature species identified throughout the Project area, were referenced during the development of riparian buffer and adjacent riparian wetland plants for the Project.

The proposed natural vegetation community will include appropriate strata (canopy, understory, shrub, and herbaceous species) based on the appropriate reference community. Within each of the four strata, a variety of species will be planted to ensure an appropriate and diverse plant community. Species proposed for revegetation planting are presented in Table 20.

Table 20. Proposed Riparian Buffer Bare Root and Live Stake Plantings

Scientific Name	Common Name	% Planting by Species	Wetland Tolerance
Riparian Buffer Bare Root Plantings – Overstory (Proposed 8' x 8' Planting Spacing @ 680 Stems/Acre)			
Betula nigra	River birch	10%	FACW
Fraxinus pennsylvanica	Green ash	3%	FACW
Platanus occidentalis	American sycamore	10%	FACW
Quercus nigra	Water oak	8%	FAC
Liriodendron tulipifera	Tulip tree	10%	FACU
Quercus alba	White oak	6%	FACU
Nyssa biflora	Swamp black gum	8%	OBL
Quercus bicolor	Swamp white oak	8%	FACW
Quercus michauxii	Swamp chestnut oak	8%	FACW
Quercus phellos	Willow oak	8%	FACW
Riparian Buffer Bare Root Plantings – Understory (Proposed 8' x 8' Planting Spacing @ 680 Stems/Acre)			
Clethra alnifolia	Sweet pepperbush	3%	FACW
Carpinus caroliniana	Ironwood	3%	FAC
Persea palustris	Red bay	3%	FACW
Eubotrys racemosus	Swamp doghobble	3%	FACW
Magnolia virginiana	Sweetbay magnolia	3%	FACW
Cyrilla racimiflora	Titi	3%	FACW
Itea virginica	Sweetspire	3%	FACW

Scientific Name	Common Name	% Planting by Species	Wetland Tolerance
Riparian Buffer Live Stake Plantings – Streambanks (Proposed 2'- 3' Spacing @ Meander Bends and 6'- 8' Spacing @ Riffle Sections)			
Cephalanthus occidentalis	Buttonbush	20%	OBL
Salix sericea	Silky willow	30%	OBL
Salix nigra	Black willow	30%	OBL
Sambucus canadensis	Elderberry	20%	FACW-
Note: Final species selection may change due to refinement or availability at the time of planting. Species substitutions will be coordinated between WLS and planting contractor prior to the procurement of plant stock and documented in the as-built report.			

6.4.2 Planting Materials and Methods

Planting will be conducted during the dormant season, with trees installed between November 15th and March 15th if possible. However, all trees must be installed by the end of April to count towards the first year of monitoring in that same year. Observations will be made during construction of the site regarding the relative wetness of areas to be planted as compared to the revegetation plan. The final planting zone limits may be modified based on these observations and comparisons, and the final selection of the location of the planted species will be matched according the species wetness tolerance and the anticipated wetness of the planting area. It should be noted that smaller tree species planted in the understory, such as Ironwood, will unlikely meet the height targets for tree species after seven years.

Plant stock delivery, handling, and installation procedures will be coordinated and scheduled to ensure that woody vegetation can be planted within two days of being delivered to the project site. Soils at the site areas proposed for planting will be prepared by sufficiently loosening prior to planting. Bare root seedlings will be manually planted using a dibble bar, mattock, planting bar, or other approved method. Planting holes prepared for the bare root seedlings will be sufficiently deep to allow the roots to spread outward and downward without "J-rooting." Soil will be loosely re-compacted around each planting, as the last step, to prevent roots from drying out.

Live Staking and Live Branch Cuttings: Where live staking is proposed, live stakes will typically be installed at a minimum of 40 stakes per 1,000 square feet and the stakes will be spaced approximately two to three feet apart in meander bends and six to eight feet apart in the riffle sections, using a triangular spacing pattern along the streambanks, between the toe of the streambank and bankfull elevation. When bioengineering is proposed, live branch cutting bundles comprised of similar live stake species, shall be installed at five linear feet per bundle approximately two to three branches thick. The basal ends of the live branch cuttings, or whips, shall contact the back of the excavated slope and shall extend six inches from the slope face.

Permanent Seeding: Permanent seed mixtures of native species herbaceous vegetation and temporary herbaceous vegetation seed mixtures will be applied to all disturbed areas of the project site. The individual species were specifically selected due to their native occurrence in Lenoir County, NC. Temporary and permanent seeding will be conducted simultaneously at all disturbed areas of the site during construction and will conducted with mechanical broadcast spreaders. Simultaneous permanent and temporary seeding activities helps to ensure rapid growth and establishment of herbaceous ground cover and promotes soil stability and riparian habitat uplift. Table 21 lists the proposed species, mixtures, and application rates for permanent seeding. The vegetation species proposed for permanent seeding are deep-rooted and have been shown to proliferate along restored stream channels, providing long-term stability.

The vegetation species proposed for temporary seeding germinate quickly to swiftly establish vegetative ground cover and thus, short term stability. The permanent seed mixture proposed is suitable for streambank, floodplain, and adjacent riparian wetland areas, and the upland transitional areas in the riparian buffer. Beyond the riparian buffer areas, temporary seeding will also be applied to all other disturbed areas of the site that are susceptible to erosion. These areas include constructed streambanks, access roads, side slopes, and spoil piles. If temporary seeding is applied from November through April, rye grain will be used and applied at a rate of 130 pounds per acre. If applied from May through October, temporary seeding will consist of browntop millet, applied at a rate of 40 pounds per acre.

Table 21. Proposed Riparian Buffer Permanent Seeding

Botanical Name	Common Name	% Proposed for Planting by Species	Seeding Rate (lb/acre)	Wetland Tolerance
Andropogon gerardii	Big blue stem	10%	1.5	FAC
Dichanthelium clandestinum	Deer tongue	15%	1.5	FACW
Carex vulpinoidea	Fox sedge	10%	2.25	OBL
Carex lupulina	Hop sedge	5%	2.25	OBL
Elymus virginicus	Virginia wild rye	15%	1.5	FAC
Juncus effusus	Soft rush	15%	2.25	FACW+
Panicum virgatum	Switchgrass	5%	1.5	FACW+
Schizachyrium scoparium	Little blue stem	10%	0.75	FACU
Tripsacum dactyloides	Eastern gamagrass	5%	0.75	FAC+
Sorghastrum nutans	Indiangrass	10%	0.75	FACU
Note: Final species selection may change due to refinement or availability at the time of planting. Species substitutions will be coordinated between WLS and planting contractor prior to the procurement of seeding stock.				

Invasive species vegetation, such as Chinese privet and multiflora rose will be treated to allow native plants to become established within the conservation easement. Larger native tree species will be preserved and harvested woody material will be utilized to provide bank stabilization cover and/or nesting habitat. Hardwood species will be planted to provide the appropriate vegetation for the restored riparian buffer areas. During the project implementation, invasive species exotic vegetation will be treated both to control its presence and reduce its spread within the conservation easement areas. These efforts will aid in the establishment of native riparian vegetation species within the restored riparian buffer areas.

In addition, vegetation planting and establishment will be done in accordance with the technical specifications. The contractor shall apply all soil amendments, such lime and fertilizer, as specified by soil test results along with temporary and permanent seed and mulch immediately prior to installing erosion control matting. Any soil amendments or vegetation deficiencies will be noted in monitoring report and adaptive management may be required, especially in in Priority Level II excavation areas.

6.5 Water Quality Treatment Features

Water quality treatment features in the form of small basins or impoundments designed to treat runoff from the surrounding agricultural runoff are proposed along the project reaches adjacent to the restored riparian buffer corridor. The small basins will capture overland flow, increase infiltration and groundwater recharge, diffuse flow energies, and allow nutrient uptake within the project area. The features are sized to treat storage volumes, which have been calculated by comparing the SCS Curve Number Method and Simple Method. The features are intended to function most similar to a stormwater wetland to temporarily store surface runoff in shallow pools that support emergent and native riparian vegetation. The features are designed and constructed such that no long-term maintenance is required. Whenever possible the features will be located within the conservation easement boundary.

The features will be excavated along non-jurisdictional flat or depressional areas where ephemeral drainages intersect with the proposed restored stream corridor. The existing ditches to remain will be connected with the restored headwater valleys and channels using the water quality improvement features described herein. The area will be improved by grading flatter side slopes (>3H:1V) and planting appropriate wetland vegetation. Over time, as vegetation becomes established, the areas will function as shallow wetland complexes or depressions. The weir and outlet channels will be constructed with suitable material and stabilized with permanent vegetation and stone that will deliver reduced runoff and prevent headcut migration or erosion into the newly constructed areas. This strategy will allow the feature to function properly with minimal risk and without long-term maintenance requirements. See Appendix 1 design plan sheets for details and feature location.

6.6 Site Construction Methods

6.6.1 Site Grading and Construction Elements

Following initial evaluation of the design criteria, detailed refinements were made to the design plans in the field to accommodate the existing valley characteristics, vegetation influences and channel morphology. This was done to minimize unnecessary disturbance of the riparian area, and to allow for some natural channel adjustments following construction. The design plans and construction elements have been tailored to produce a cost and resource efficient design that is constructible, using a level of detail that corresponds to the tools of construction. A general construction sequence is included on the project design plan sheets located in Appendix 1.

Some of the grading across the lower site will be conducted within the existing riparian corridor. The restored streams will be excavated within the existing headwater valley. Suitable fill material will be generated from new channel excavation and adjacent upland areas and hauled to ditch fill/plugs or stockpile locations as necessary. Portions of the existing, unstable channels will be partially to completely filled in along their length using compactable material excavated from construction of the restored channels. Floodplain grading activities will focus on restoring pre-disturbance valley topography by removing field crowns, overburden/spoil, surface drains that were imposed during conversion of the land for agriculture. In general, floodplain grading activities will be minor, with the primary goal of soil scarification, creating depressional areas, water quality and habitat features, and microtopographic crenulations by filling the drainage features on the site back to natural ground elevations (Scherrer, 1999).

6.6.2 In-stream Structures and Floodplain Improvement Features

A variety of in-stream structures are proposed for the project. Structures including log vanes, constructed wood riffles, rootwads, log weirs and log step pools. Geolifts with toe wood, various other bioengineering measures, and native species vegetation transplants will be used to stabilize the newly restored stream and improve bedform diversity and habitat functions. All in-stream structures will be constructed from native materials such as hardwood trees, trunks/logs, brush/branches, and gravel stone materials. Native woody debris will be harvested on-site during the project construction and incorporated into the stream channel restoration whenever possible. To ensure sustainability of these structures, WLS will use design and construction methods that have proven successful on numerous past projects in the same geographic region and similar site conditions.

Floodplain features such as depressions and tree throws are commonly found in natural riparian systems. These features will be appropriately added to provide additional habitat and serve as water storage and sediment sinks throughout the restoration corridor. When appropriate, these features will be added adjacent to abandoned channel sections and/or strategic locations throughout the floodplain to provide habitat and serve as water storage and sediment sinks throughout the corridor (Metcalf, 2004).

6.6.3 Construction Feasibility

WLS has field verified that the project site has adequate, viable construction access, staging, and stockpile areas. Physical constraints or barriers, such as stream crossings or ROWs, account for only a small percentage of the proposed total stream reach length within the project boundary. Existing site access points and features may be used for future access after the completion of construction. Any potential impacts to existing wetland areas will be avoided whenever possible during construction. Only minimal, temporary impacts will be allowed when necessary for maximized permanent stream, wetland, and riparian buffer functional uplift.

7 Performance Standards

The success criteria for the project will follow the approved performance standards and monitoring protocols presented in this mitigation plan, which have been developed in compliance with the *DMS Stream and Wetland Mitigation Plan Template Guidance*, adopted June 2017, as well as the *USACE Wilmington District Stream and Wetland Compensatory Mitigation Update* issued in October 2016, and *Compensatory Mitigation for Losses of Aquatic Resources; Final Rule,* issued in 2008. In addition, the monitoring success criteria, practices, and corresponding reporting will follow information required by current DMS templates and guidance as referenced in the RFP. Monitoring activities will be conducted for a period of seven years with the final duration dependent upon performance trends toward achieving project goals and objectives. Specific success criteria components and evaluation methods are described below.

7.1 Single-Thread Streams

***Stream Hydrology*:** Four bankfull flow events must be documented within the seven-year monitoring period. The bankfull events must occur in separate years. Otherwise, the stream monitoring will continue until four bankfull events have been documented in separate years. Surface flow for restored intermittent streams will be documented using gauges or automated data loggers.

Stream Profiles, Vertical Stability, and Floodplain Access: Stream profiles, as a measure of vertical stability and floodplain access will be evaluated by looking at Bank Height Ratios (BHR). In addition, observed bedforms should be consistent with those observed for channels of the design stream type(s). The BHR shall not exceed 1.2 along the restored Project stream reaches. This standard only applies to restored reaches of the channel where BHRs were corrected through design and construction. Vertical stability and floodplain access will both be evaluated by evaluating Entrenchment Ratios (ER) which is lateral extent of flooding during bankfull. The ER shall be no less than 2.2 for restored 'C' or 'E' stream types (≥1.4 for 'B' stream types). This standard only applies to restored reaches of the channel where ERs were corrected through design and construction.

Stream Horizontal Stability: Cross-sections will be used to document stability of stream dimension. There should be minimal change expected in post-restoration cross-sections. If measurable changes do occur, they should be evaluated to determine if the changes represent a movement toward a more unstable condition (e.g., downcutting, erosion) or a movement towards increased stability (e.g., settling, vegetation establishment, deposition along the streambanks, decrease in width/depth ratio). Cross-sections shall be documented using the Rosgen Stream Classification method and all monitored cross-sections should fall within the quantitative parameters defined for channels of the design stream type. Per USACE 2016 guidance, ER and BHR at any measured riffle cross-section should not change by more than 10% from the baseline condition during any given monitoring interval. repair. If this number exceeds 15%, the stream reach may need remedial action or repair as decided by the NCIRT on a case-by-case basis.

Streambed Material Condition and Stability: After construction, it anticipated that particle size distributions will adjust as appropriate for sand dominated supply. Some fining of stream bed material may occur during the first few years after construction. However, long term trends are anticipated to demonstrate minimal change in the particle size distribution of the streambed materials, over time, given the current watershed conditions and future upstream sediment supply regime. Since the streams are predominantly sand-bed systems, significant changes in particle size distribution are not expected.

Jurisdictional Stream Flow: The restored stream systems classified as intermittent and/or ephemeral must exhibit base flow for at least 30 consecutive days of the year during a year under normal rainfall conditions.

7.2 Headwater Streams

Continuous Flow: Surface flow must be documented using gauges (pressure transducers) or automated photo loggers.

Channel Formation: Channel formation within the valley or crenulation must be documented through identification of field indicators consistent with USACE 2016 guidance, RGL 05-05 and monitoring methods and activities described in Section 8.

7.3 Vegetation

Vegetative restoration success for the project during the intermediate monitoring years will be based on the survival of at least 320, three-year-old planted trees per acre at the end of Year 3 of the monitoring period (MY3) and at least 260, five-year-old, planted trees per acre at the end of Year 5 of the monitoring period (MY5). The final vegetative restoration success criteria will be achieving a density of no less than 210, seven-year-old planted stems per acre in Year Seven of monitoring (MY7). In addition, planted trees in each vegetation plot must average 7 feet in height after MY5 and 10 feet in height at MY7 before closeout.

8 Monitoring Plan

In accordance with the approved mitigation plan, the baseline monitoring document and as-built report documenting the mitigation activities will be developed within 60 days of the completion of planting and monitoring device installation at the Project. In addition, a period of at least six months will separate the as-built baseline measurements and the first-year monitoring measurements. The baseline monitoring document and as-built monitoring report will include all information required by current DMS templates and guidance as referenced in the RFP, including planimetric (plan view) and elevation (profile view) information, photographs, sampling plot locations, a description of initial vegetation species composition by community type, and location of monitoring stations. The report will include a list of the vegetation species planted, along with the associated planting densities.

WLS will conduct mitigation performance monitoring based on these methods and will submit annual monitoring reports to DMS by December 31st of each monitoring year during which required monitoring is conducted. The annual monitoring reports will organize and present the information resulting from the methods described in detail below. The annual monitoring reports will provide a project data chronology for DMS to document the project status and trends, for population of DMS's databases for analyses, for research purposes, and to assist in decision making regarding project close-out. Project success criteria must be met by the final monitoring year prior to project closeout, or monitoring will continue until unmet criteria are successfully met. Table 22 in Section 8.5 summarizes the monitoring methods and linkage between the goals, parameters, and expected functional lift outcomes. Figure 6 illustrates the pre-construction and Figure 10 illustrates the post-construction monitoring feature types and location.

8.1 Visual Assessment Monitoring

WLS will conduct visual assessments in support of mitigation performance monitoring. Visual assessments of all stream reaches will be conducted twice per monitoring year with at least five months in between each site visit for each of the seven years of monitoring. Photographs will be used to visually document system performance and any areas of concern related to streambank and bed stability, condition of in-stream structures, channel migration, active headcuts, live stake mortality, impacts from invasive plant species or animal browsing, easement boundary encroachments, and the general condition of pools and riffles. The monitoring activities will be summarized in DMS's *Visual Stream Morphology Stability*

Assessment Table and the *Vegetation Conditions Assessment Table* as well as a *Current Conditions Plan View (CCPV) drawing* formatted to DMS digital drawing requirements, which are used to document and quantify the visual assessment throughout the monitoring period.

A series of photographs over time will be also be compared to subjectively evaluate channel aggradation (i.e. bar formations) or degradation, streambank erosion, successful maturation of riparian vegetation, and effectiveness of sedimentation and erosion control measures. More specifically, the longitudinal profile photos should indicate the absence of developing bars within the channel or excessive increase in channel depth, while lateral photos should not indicate excessive erosion or continuing degradation of the banks. Fixed photo points will be located at each cross-section as well as at each culvert crossing. The photographs will be taken from a height of approximately five feet to ensure that the same locations (and view directions) at the site are documented in each monitoring period and will be shown on a plan view map. The results of the visual monitoring assessments will be used to support the development of the annual monitoring document that provides the visual assessment metrics.

8.2 Stream Assessment Monitoring

Based on the stream design approaches, different stream monitoring methods are proposed for the various project reaches. Hydrologic monitoring will be conducted for all project stream reaches that involve both single-thread channel (Rosgen Priority Level I and II) and headwater stream restoration approaches. The geomorphic monitoring methods will follow recommendations by the *USACE 2016 Monitoring Guidelines* to evaluate the effectiveness of the restoration practices. For Project reaches involving headwater stream restoration, surface water flow and channel formation will be documented. Visual monitoring will be conducted along project reaches and efforts will focus primarily on visual inspections, photo documentation, and vegetation assessments, each as described under visual monitoring. Each of the proposed stream monitoring methods are described herein.

8.2.1 Hydrologic Monitoring

The occurrence of four (4) required bankfull events (overbank flows) within the monitoring period, along with floodplain access by flood flows, will be documented using automated gauges (pressure transducers) and photography. The gauges will be installed on the floodplain of and across the dimension of the restored single thread-channels as needed for monitoring. The gauges will record the watermark associated with the highest flood stage between monitoring site visits. The gauges will be used to determine if a bankfull or significant flow event has occurred since the previous gauge check. Corresponding photographs will be used to document the occurrence of debris lines and sediment deposition on the floodplain during monitoring site visits. This hydrologic monitoring will help establish that the project objective of restoring floodplain functions and promoting more natural flood processes are being met.

8.2.2 Geomorphic Monitoring

Horizontal Pattern: A planimetric survey will be conducted for the entire length of restored channel immediately after construction to document as-built baseline conditions (Monitoring Year 0). The survey will be tied to a permanent benchmark and measurements will include thalweg, bankfull, and top of banks. The plan view measurements such as sinuosity, radius of curvature, meander width ratio will be taken on newly constructed meanders during baseline documentation (Monitoring Year 0) only. The described visual monitoring will also document any changes or excessive lateral movement in the plan view of the restored channel. The results of the planimetric survey should show that the restored horizontal geometry is consistent with intended design stream type. These measurements will demonstrate that the restored stream channel pattern provides more stable planform and associated features than the old channel, which provide improved aquatic habitat and geomorphic function, as per the restoration objectives.

Longitudinal Profile: A longitudinal profile will be surveyed for the entire length of restored channel immediately after construction to document as-built baseline conditions for the first year of monitoring only. The survey will be tied to a permanent benchmark and measurements will include thalweg, water surface, bankfull, and top of low bank. Each of these measurements will be taken at the head of each feature (e.g., riffle, pool) and at the maximum pool depth. The longitudinal profile should show that the bedform features installed are consistent with intended design stream type. The longitudinal profiles will not be taken during subsequent monitoring years unless vertical channel instability has been documented or remedial actions/repairs are deemed necessary. These measurements will demonstrate that the restored stream profile provides more bedform diversity than the old channel with multiple facet features (such as scour pools and riffles) that provide improved aquatic habitat, as per the restoration objectives. BHRs will be measured along each of the restored reaches using the results of the longitudinal profile.

Horizontal Dimension: Permanent cross-sections will be installed and surveyed at an approximate rate of one cross-section per twenty (20) bankfull widths or an average distance interval (not to exceed 500 LF) of restored stream, with approximately six (6) cross-sections located at riffles, four (4) located at pools, and two (2) located across the headwater valley reaches. Each cross-section will be monumented to establish the exact transect used and to facilitate repetition each year and easy comparison of year-to-year data. The cross-section surveys will occur in years 0 (as-built), 1, 2, 3, 5, and 7, and will include measurements of bankfull cross-sectional area (Abkf) at low bank height, Bank Height Ratio (BHR) and Entrenchment Ratio (ER). The monitoring survey will include points measured at all breaks in slope, including top of streambanks, bankfull, inner berm, edge of water, and thalweg, if the features are present. There should be minimal change in as-built cross-sections. Stable cross-sections will establish that the restoration goal of creating geomorphically stable stream conditions has been met. If changes do take place, they will be documented in the survey data and evaluated to determine if they represent a movement toward a more unstable condition (e.g., down-cutting or erosion) or a movement toward increased stability (e.g., settling, vegetative changes, deposition along the streambanks, or decrease in width-to-depth ratio). All monitored cross-sections should fall within the quantitative parameters defined for channels of the design stream type using the Rosgen Classification System. Given the smaller channel sizes and meander geometry of the proposed steams, bank pin arrays will not be installed unless monitoring results indicate active lateral erosion at cross-sections occurring in meander bends, typically at pools.

Reference photo transects will be taken at each permanent cross-section. Photos should not indicate excessive erosion or continuing degradation of the streambanks. Photographs will be taken of both streambanks looking downstream at each cross-section. A survey tape stretched between the permanent cross-section monuments/pins will be centered in each of the streambank photographs. The water elevation will be shown in the lower edge of the frame, and as much of the streambank as possible will be included in each photo. Photographers should attempt to consistently maintain the same area in each photo over time.

8.2.3 *Flow Duration Monitoring*

Monitoring of stream flow will be conducted to demonstrate that the restored stream channels exhibit surface flow for a minimum of 30 consecutive days throughout some portion of the year during a year with normal rainfall conditions. To determine if rainfall amounts are normal for the given year, a rainfall gauge will be installed on the site to compare precipitation amounts using tallied data obtained from on site and the KINS-Cunningham Research station. If a normal year of precipitation does not occur during the first seven years of monitoring, monitoring of flow conditions on the site will continue until it documents that the streams have been flowing intermittently during the appropriate times of the year.

The proposed flow monitoring of reaches MS1, UT1 and UT2 will include the installation of continuous stream stage recorders within the bottom (toe of slope) of the channel towards the upper one-third of the reach. In addition, photographic documentation may be used to subjectively evaluate and document channel flow conditions throughout the year. More specifically, the longitudinal photos should indicate the presence of flow within the channel to illustrate water levels within the pools and riffles. The photographs will be taken from a height of approximately five feet to ensure that the same locations (and view directions) at the site are documented in each monitoring period and will be shown on a plan view map.

Monitoring flow gauges (continuous-read pressure transducers) will be installed towards the upper one-third of restored intermittent reaches. The devices will be inspected on a quarterly basis to document surface flow hydrology and provide a basis for evaluating flow response to rainfall events and surface runoff during various water tables levels throughout the monitoring period (KCI, DMS, 2010).

8.2.4 *Headwater Stream Monitoring*

Continuous Surface Flow: Continuous surface water flow within the valley or crenulation must be documented to occur every year for at least 30 consecutive days during the prescribed monitoring period. Additional monitoring may be required if surface water flow cannot be documented due to abnormally dry conditions.

Channel Formation: During monitoring years 1 through 4, the preponderance of evidence must demonstrate a concentration of flow indicative of channel formation within the topographic low-point of the valley or crenulation as documented by the following indicators:

- Scour (indicating sediment transport by flowing water)
- Sediment deposition (accumulations of sediment and/or formation ripples)
- Sediment sorting (sediment sorting indicated by grain-size distribution with the primary path of flow)
- Multiple observed flow events (must be documented by gage data and/or photographs)
- Destruction of terrestrial vegetation
- Presence of litter and debris
- Wracking (deposits of drift material indicating surface water flow)
- Vegetation matted down, bent, or absent (herbaceous or otherwise)
- Leaf litter disturbed or washed away

During monitoring years 5 through 7, the stream must successfully meet the requirements above and the preponderance of evidence must demonstrate the development of stream bed and banks as documented by the following indicators:

- Bed and banks (may include the formation of stream bed and banks, development of channel pattern such as meander bends and/or braiding at natural topographic breaks, woody debris, or plant root systems)
- Natural line impressed on the bank (visible high water mark)
- Shelving (shelving of sediment depositions indicating transport)
- Water staining (staining of rooted vegetation)
- Change in plant community (transition to species adapted for flow or inundation for a long duration, including hydrophytes)

Changes in character of soil (texture and/or chroma changes when compared to the soils abutting the primary path of flow).

8.3 Vegetation Monitoring

Successful restoration of the vegetation at the project site is dependent upon successful hydrologic restoration, active establishment and survival of the planted preferred canopy vegetation species, and volunteer regeneration of the native plant community. To determine if these criteria are successfully achieved, vegetation-monitoring quadrants or plots will be installed and monitored across the restoration site in accordance with the CVS-EEP Level I & II Monitoring Protocol (CVS, 2008) and DMS Stream and Wetland Monitoring Guidelines (DMS, 2014). The vegetation monitoring plots shall be approximately 2% of the planted portion of the site with a minimum of seven (7) plots established randomly within the planted riparian buffer areas. The sampling may employ quasi-random plot locations which may vary upon approval from DMS and NCIRT. Any random plots should comprise no more than 50% of the total required plots, and the location (GPS coordinates and orientation) will identified in the monitoring reports.

No monitoring quadrants will be established within undisturbed wooded areas, however visual observations will be documented in the annual monitoring reports to describe any changes to the existing vegetation community. The size and location of individual quadrants will be 100 square meters (10m X 10m or 5m X 20m) for woody tree species and may be adjusted based on site conditions after construction activities have been completed. Vegetation monitoring will occur in the fall each required monitoring year, prior to the loss of leaves. Mortality will be determined from the difference between the previous year's living, planted seedlings and the current year's living, planted seedlings. Data will be collected at each individual quadrant and will include specific data for monitored stems on diameter, height, species, date planted, and grid location, as well as a collective determination of the survival density within that quadrant. Relative values will be calculated, and importance values will be determined. Individual planted seedlings will be marked at planting or monitoring baseline setup so that those stems can be found and identified consistently each successive monitoring year.

Volunteer species will be noted and if they are on the approved planting list and meet success criteria standards, they will be counted towards success criteria. Other species not included on the list may be considered by the NCIRT on a case-by-case basis. The presence of invasive species vegetation within the monitoring quadrants will also be noted, as will any wildlife effects. At the end of the first full growing season (from baseline/year 0) or after 180 days, species composition, stem density and survival will be evaluated. For each subsequent year, vegetation plots shall be monitored for seven years in years 1, 2, 3, 5 and 7, and visual monitoring in years 4 and 6, or until the final success criteria are achieved.

While measuring species density is the current accepted methodology for evaluating vegetation success on mitigation projects, species density alone may be inadequate for assessing plant community health. For this reason, the vegetation monitoring plan will incorporate the evaluation of native volunteer species, and the presence of invasive species vegetation to assess overall vegetative success.

WLS will provide required remedial action on a case-by-case basis, such as replanting more wet/drought tolerant species vegetation, conducting beaver and beaver dam management/removal, and removing undesirable/invasive species vegetation, and will continue to monitor vegetation performance until the corrective actions demonstrate that the site is trending towards or meeting the standard requirement. Existing mature woody vegetation will be visually monitored during annual site visits to document any mortality, due to construction activities or changes to the water table, that negatively impact existing forest cover or favorable buffer vegetation.

Table 22. Proposed Monitoring Plan Summary

Functional Category (Level)	Project Goal / Parameter	Measurement Method	Performance Standard	Potential Functional Uplift
Hydrology (Level 1)	Improve Base Flow Duration and Overbank Flows (i.e. channel forming discharge)	Flow device (pressure transducer), regional curve, regression equations, catchment assessment	Maintain seasonal flow for a minimum of 30 consecutive days during normal annual rainfall.	Create a more natural and higher functioning headwater flow regime and provide aquatic passage.
Hydraulics (Level 2)	Reconnect Floodplain / Increase Floodprone Area Widths	Bank Height Ratio, Entrenchment Ratio, crest gauge	Maintain average BHRs ≤1.2 and ERs ≥2.2 for Rosgen 'C' or 'E' (≥1.4 for 'B' stream types) and document out of bank and/or significant flow events using pressure transducers or photographs & crest gauges	Provide temporary water storage and reduce erosive forces (shear stress) in channel during larger flow events.
Geomorphology (Level 3)	Improve Bedform Diversity	Pool to Pool spacing, riffle-pool sequence, pool max depth ratio, Longitudinal Profile	Increase riffle/pool percentage and pool-to-pool spacing ratios compared to reference reach conditions.	Provide a more natural stream morphology, energy dissipation and aquatic habitat/refugia.
	Increase Vertical and Lateral Stability	BEHI / NBS, Cross-sections and Longitudinal Profile Surveys, visual assessment	Decrease streambank erosion rates comparable to reference condition cross-section, pattern and vertical profile values.	Reduce sedimentation, excessive aggradation, and embeddedness to allow for interstitial flow habitat.
	Establish Riparian Buffer Vegetation	CVS Level I & II Protocol Tree Veg Plots (Strata Composition, Vigor, and Density), visual assessment	Within planted portions of the site, a minimum of 320 stems per acre must be present at year three; a minimum of 260 stems per acre must be present at year five; and a minimum of 210 stems per acre and average 10-foot tree heights must be present at year seven.	Increase woody and herbaceous vegetation will provide channel stability and reduce streambank erosion, runoff rates and exotic species vegetation.
Physiochemical (Level 4)	Improve Water Quality	N/A	N/A	Removal of excess nutrients and organic pollutants will increase the hyporheic exchange and dissolved oxygen (DO) levels.
Biology (Level 5)	Improve Benthic Macroinvertebrate Communities and Aquatic Health	DWR Small Stream/ Benthic sampling, IBI	N/A	Increase leaf litter and organic matter critical to provide in-stream cover/shade, wood recruitment, and carbon sourcing.

Note: Level 4 and 5 project parameters and monitoring activities will not be tied to performance standards nor required to demonstrate success for credit release.

9 Adaptive Management Plan

In the event the mitigation site or a specific component of the mitigation site fails to achieve the necessary performance standards as specified in the mitigation plan, the sponsor shall notify the members of the NCIRT and work with the NCIRT to develop contingency plans and remedial actions.

10 Long-Term Management Plan

The site will be transferred to the NCDEQ Stewardship Program. This party shall serve as conservation easement holder and long-term steward for the property and will conduct periodic inspection of the site to ensure that restrictions required in the conservation easement are upheld. Funding will be supplied by the responsible party on a yearly basis until such time and endowments are established. The NCDEQ Stewardship Program is developing an endowment system within the non-reverting, interest-bearing Conservation Lands Stewardship Endowment Account. The use of funds from the Endowment Account is governed by NC General Statue GS 113A-232(d) (3). Interest gained by the endowment fund may be used only for stewardship, monitoring, stewardship administration, and land transaction costs, if applicable.
WLS does not expect that easement compliance and management will require any additional or alternative management planning, strategies or efforts beyond those typically prescribed and followed for DMS full-delivery projects.

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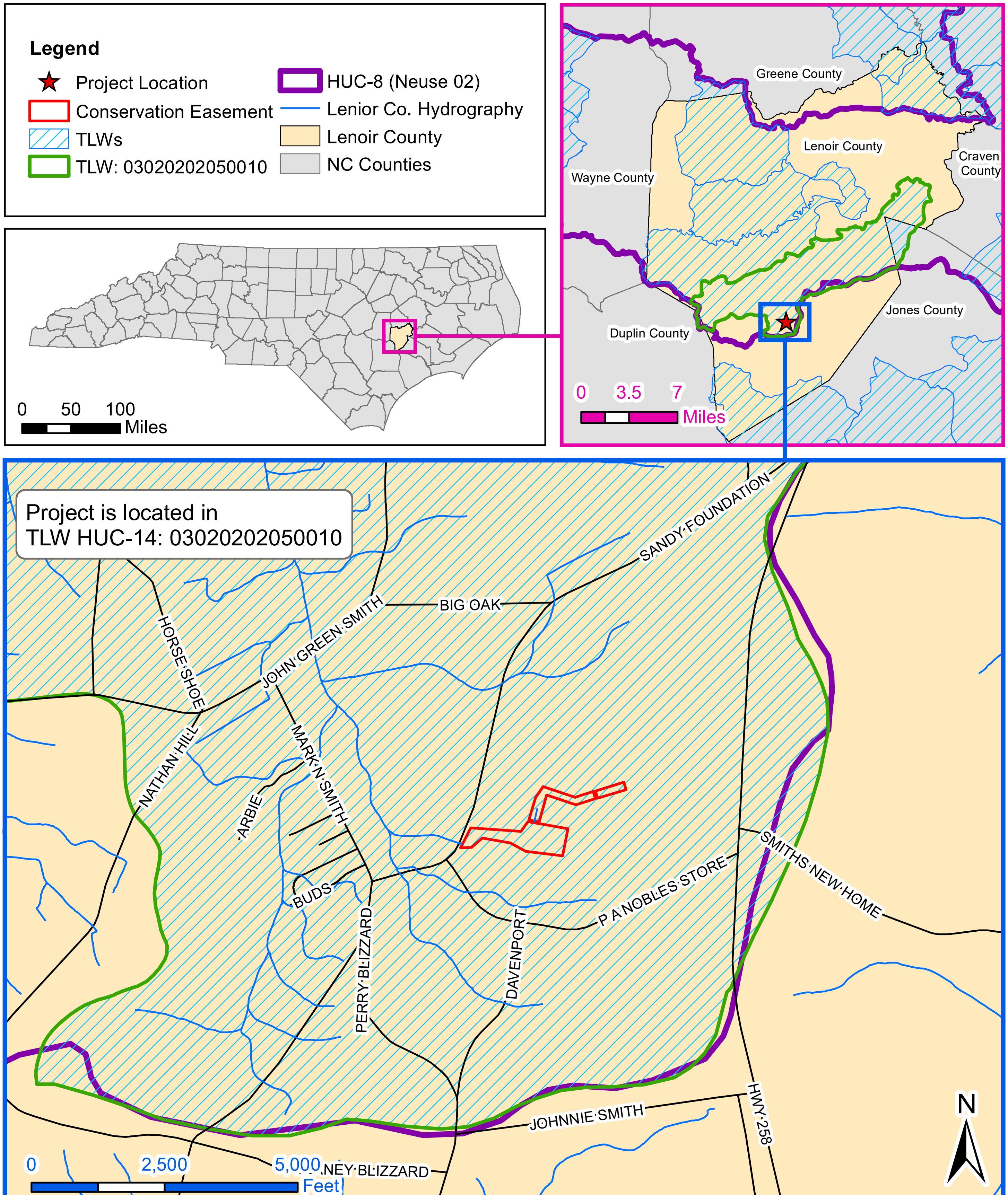
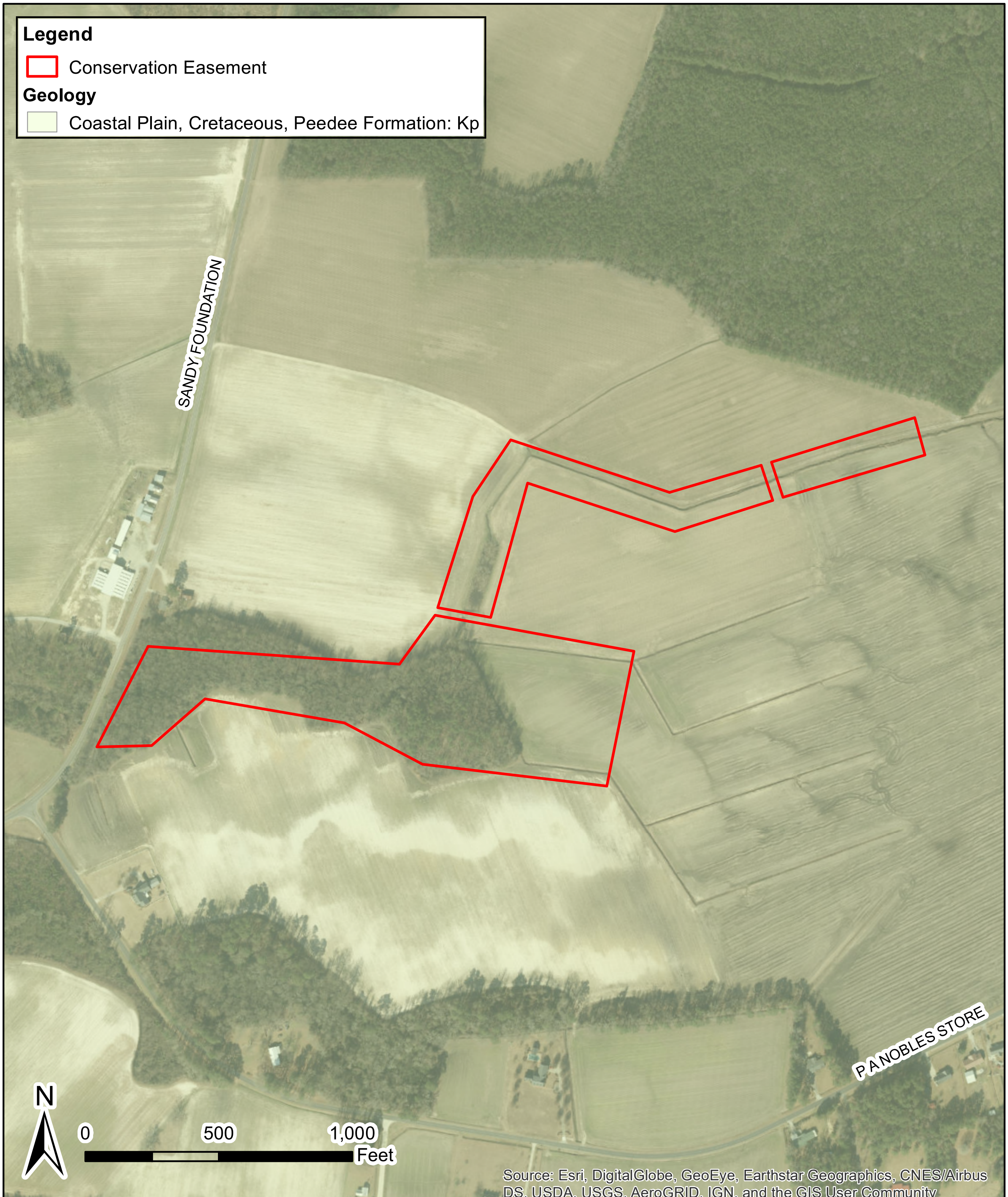
Figures

Hornpipe Branch Tributaries Mitigation Project



WATER & LAND™ SOLUTIONS	Hornpipe Branch Tributaries Mitigation Project	Project Location	FIGURE 1
		NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US	



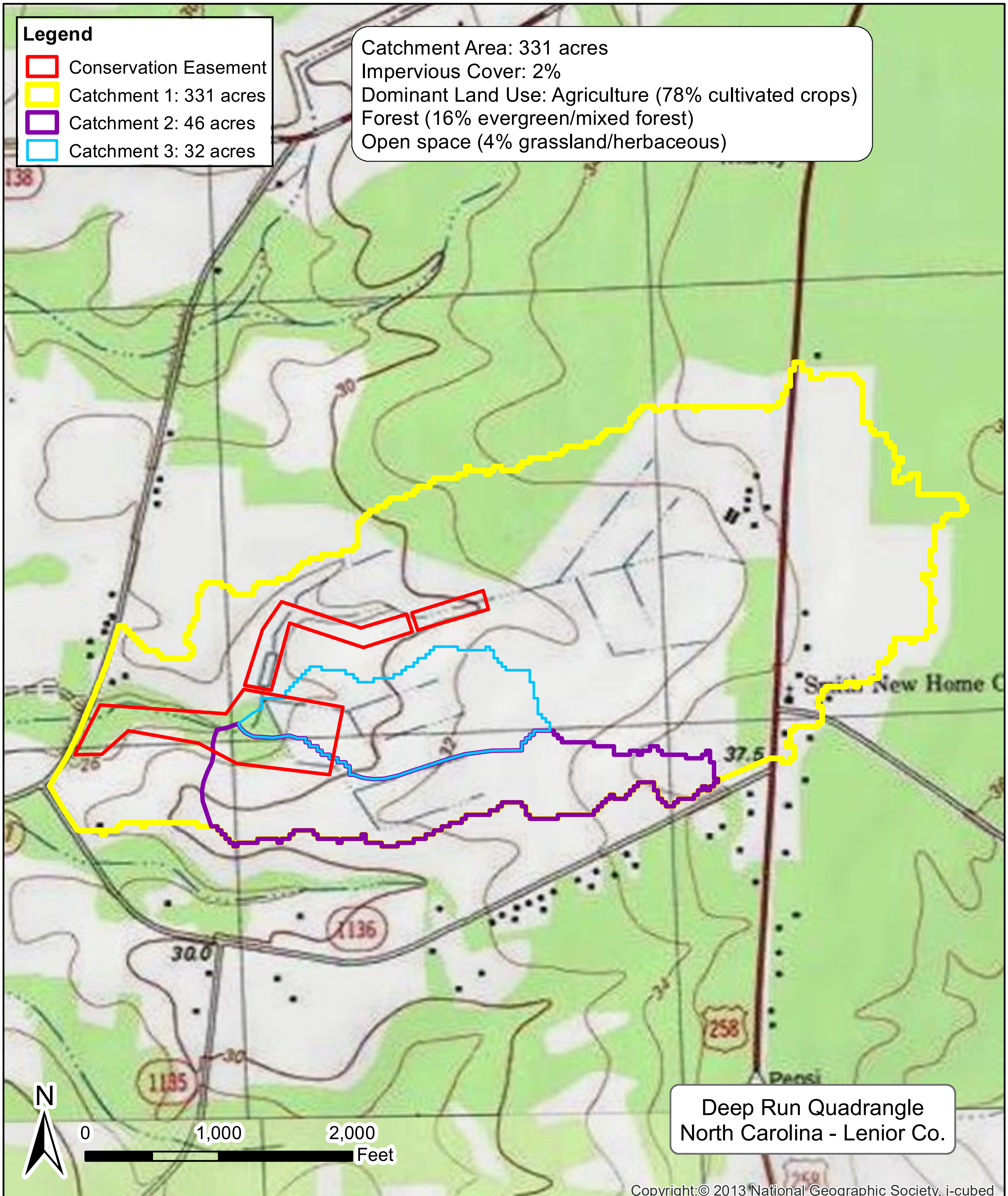
WATER & LAND™ SOLUTIONS

Hornpipe Branch Tributaries Mitigation Project

Geologic Map

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE 2



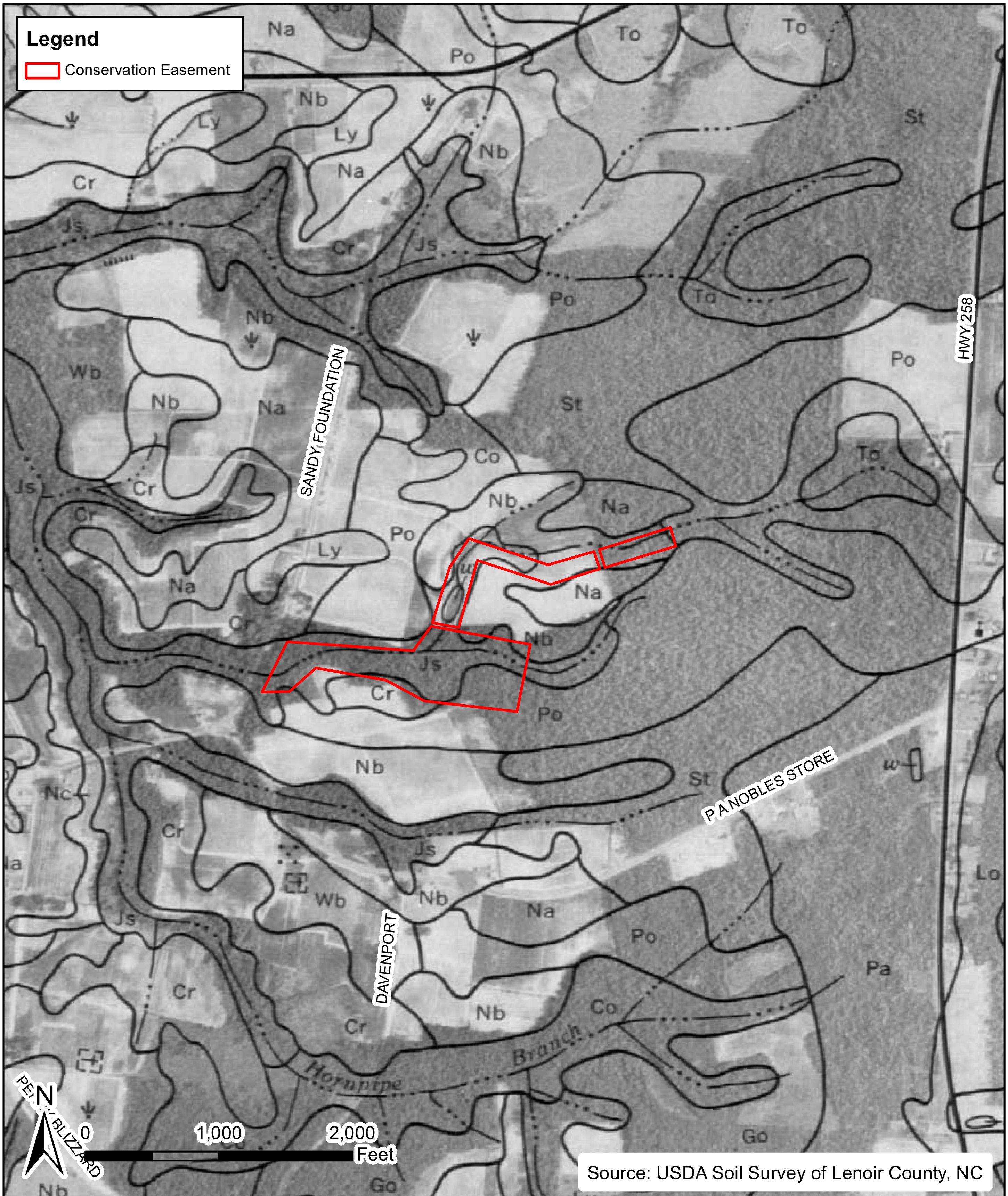
WATER & LAND™ SOLUTIONS

Hornpipe Branch Tributaries Mitigation Project

USGS Topographic Map

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE 3



WATER & LAND™ SOLUTIONS

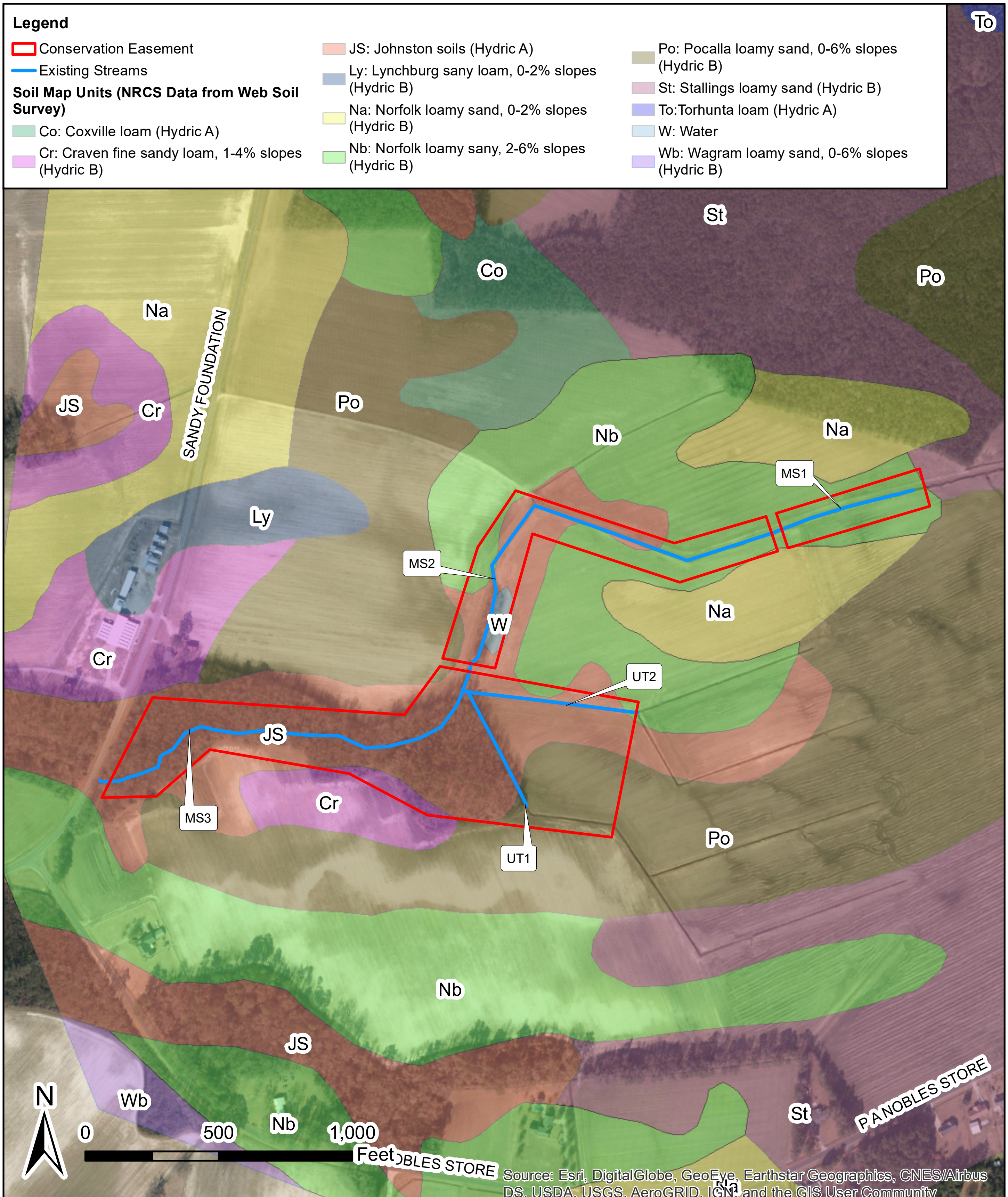
Hornpipe Branch Tributaries Mitigation Project

NRCS 1974 Soils Map

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE

4a



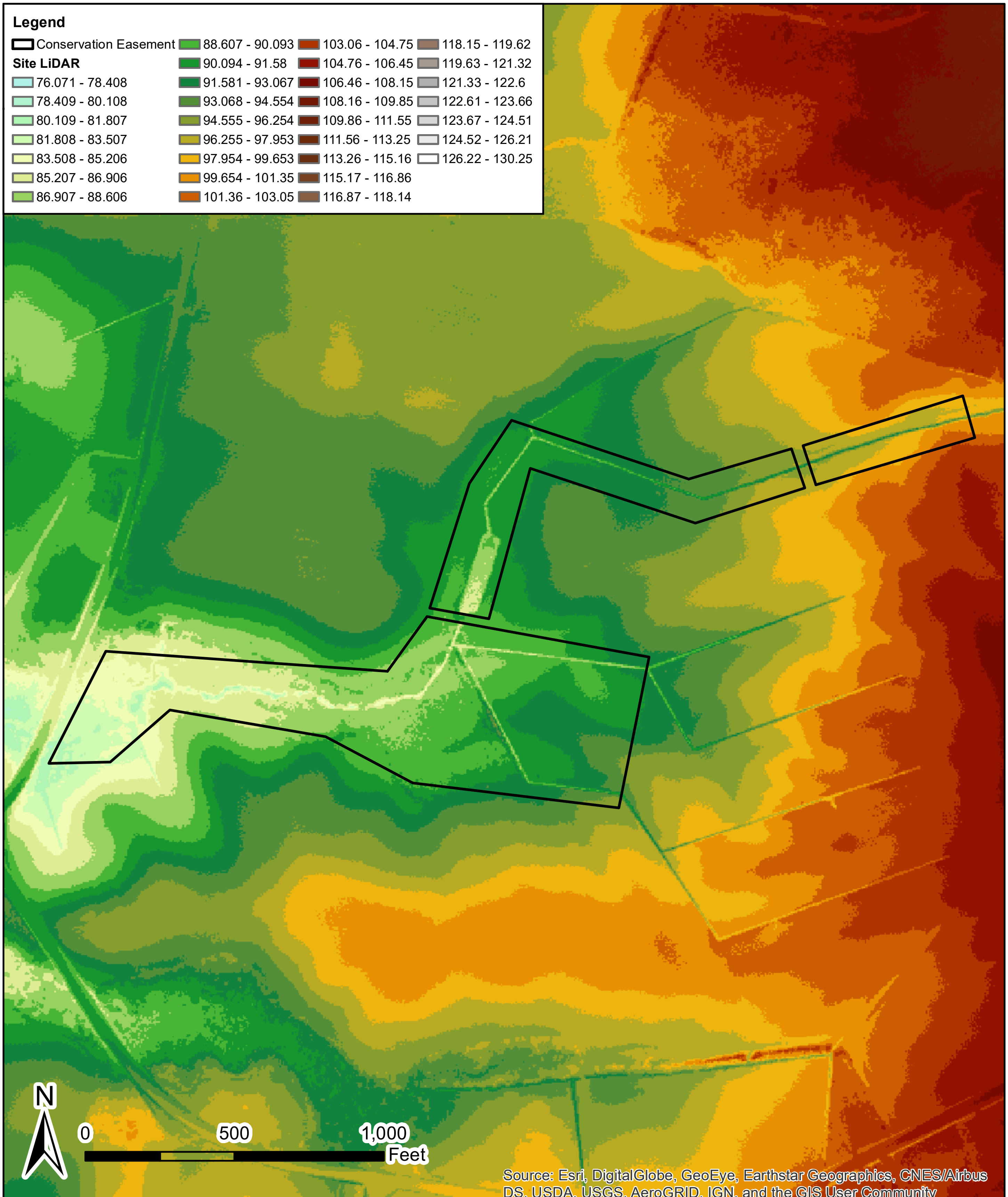
WATER & LAND™ SOLUTIONS

Hornpipe Branch Tributaries Mitigation Project

NRCS Soils Map

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE **4b**



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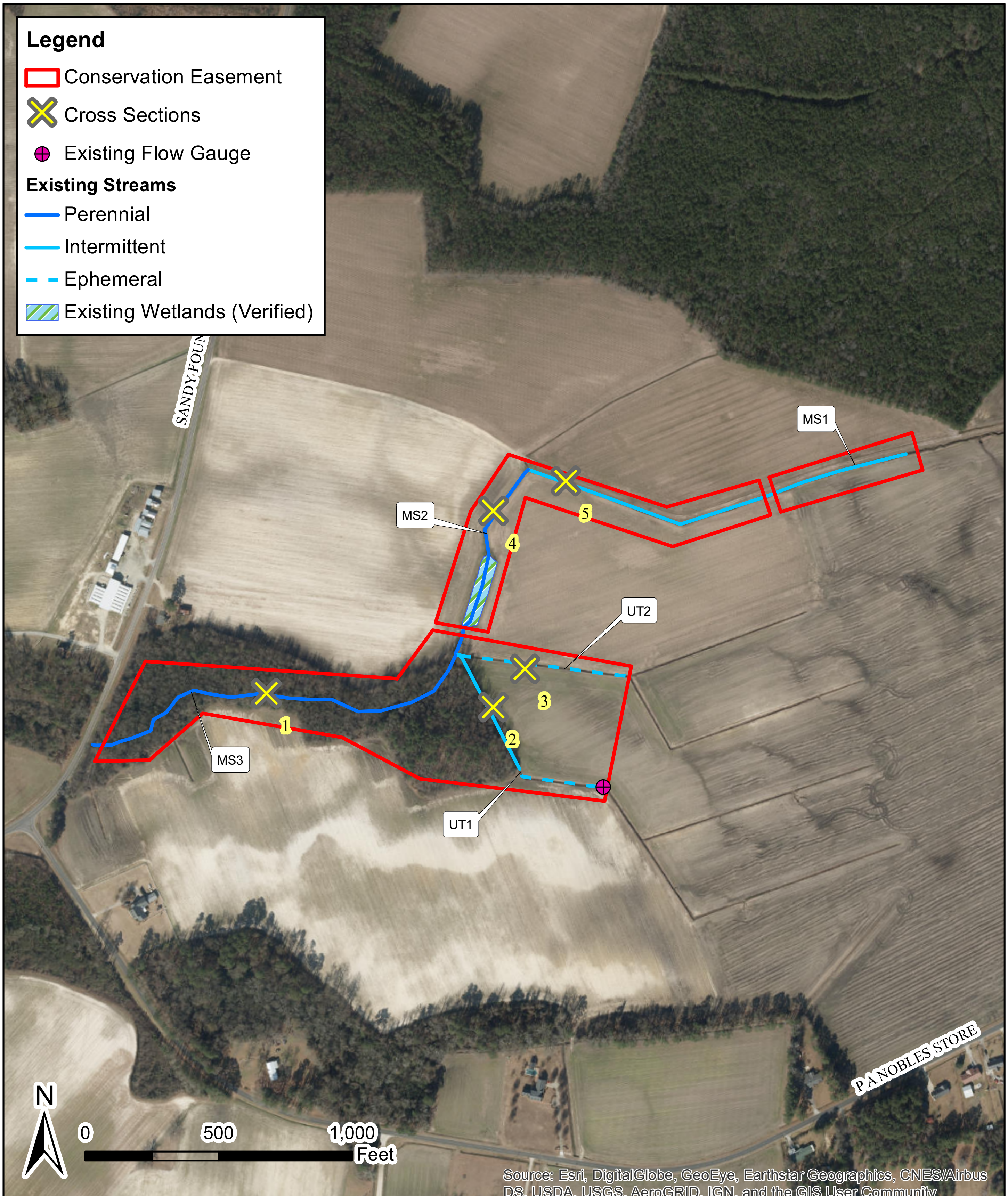
Hornpipe Branch Tributaries Mitigation Project

LiDAR Map

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE 5



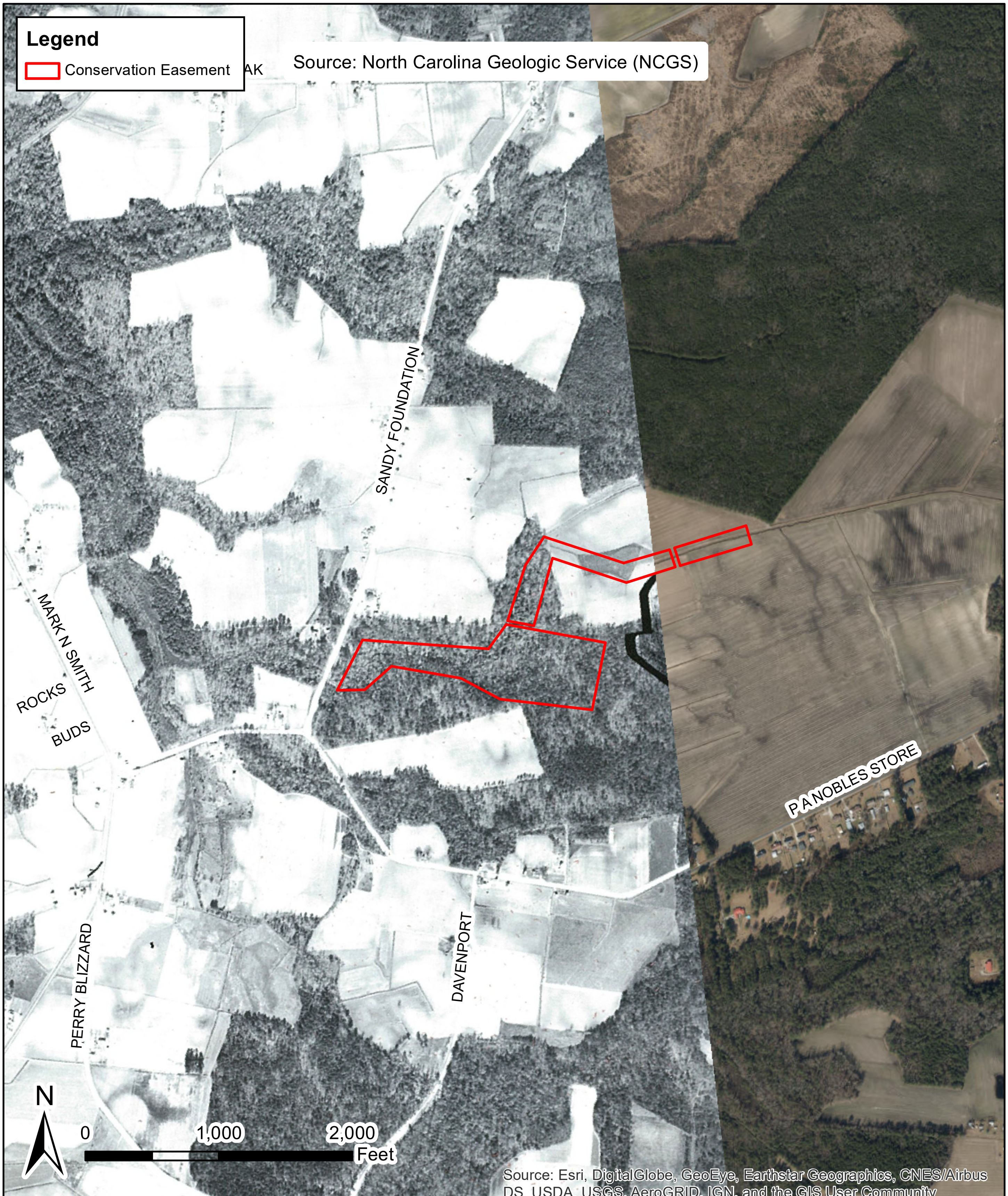
WATER & LAND™ SOLUTIONS

Hornpipe Branch Tributaries Mitigation Project

Current Conditions

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE 6



WATER & LAND™ SOLUTIONS	Hornpipe Branch Tributaries Mitigation Project	1954 Aerial Photograph **NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US**	FIGURE **7a**

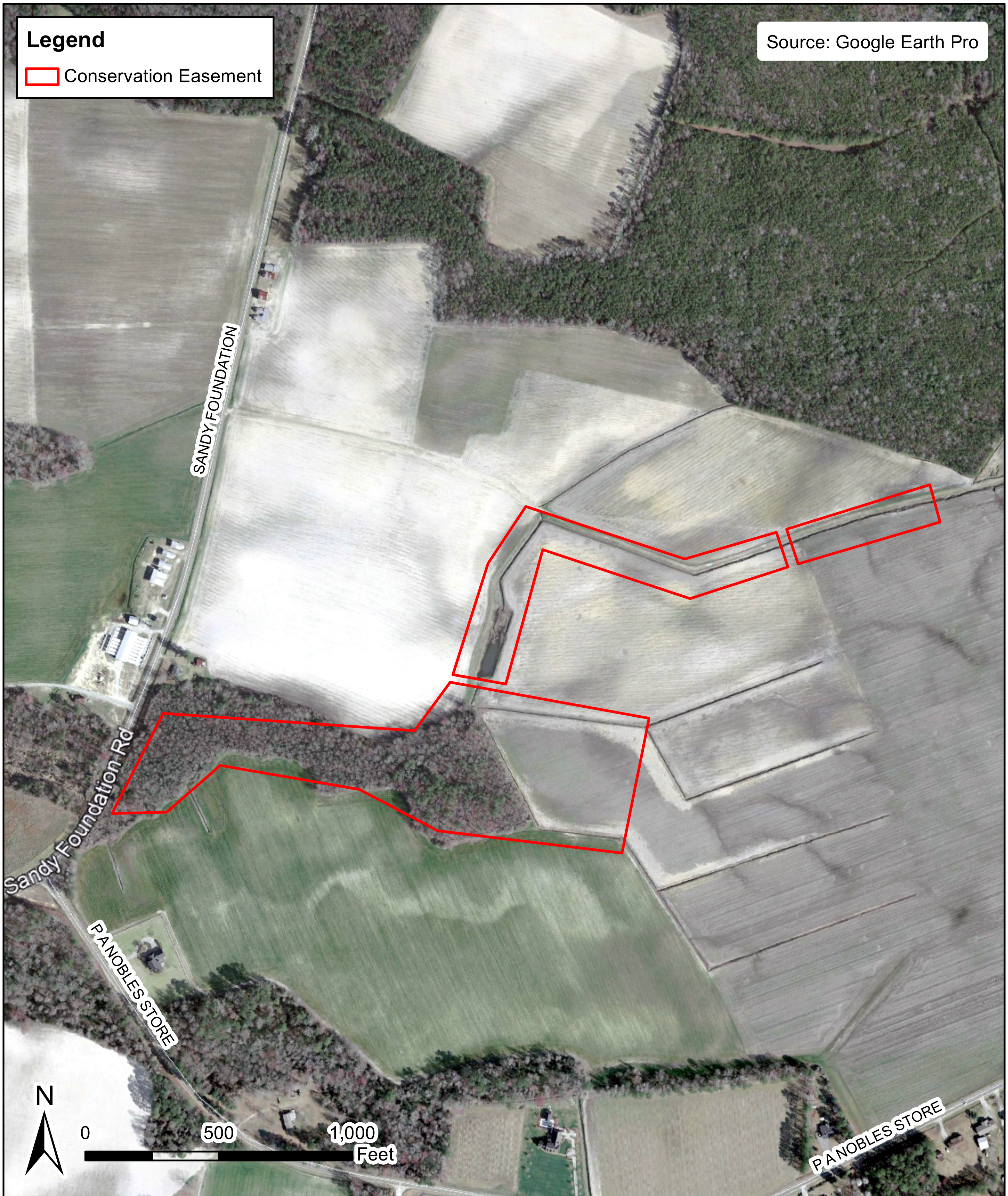
WATER & LAND™ SOLUTIONS

Hornpipe Branch Tributaries Mitigation Project

1998 Aerial Photograph

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE **7b**



WATER & LAND™ SOLUTIONS

Hornpipe Branch Tributaries Mitigation Project

2008 Aerial Photograph

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE

7c

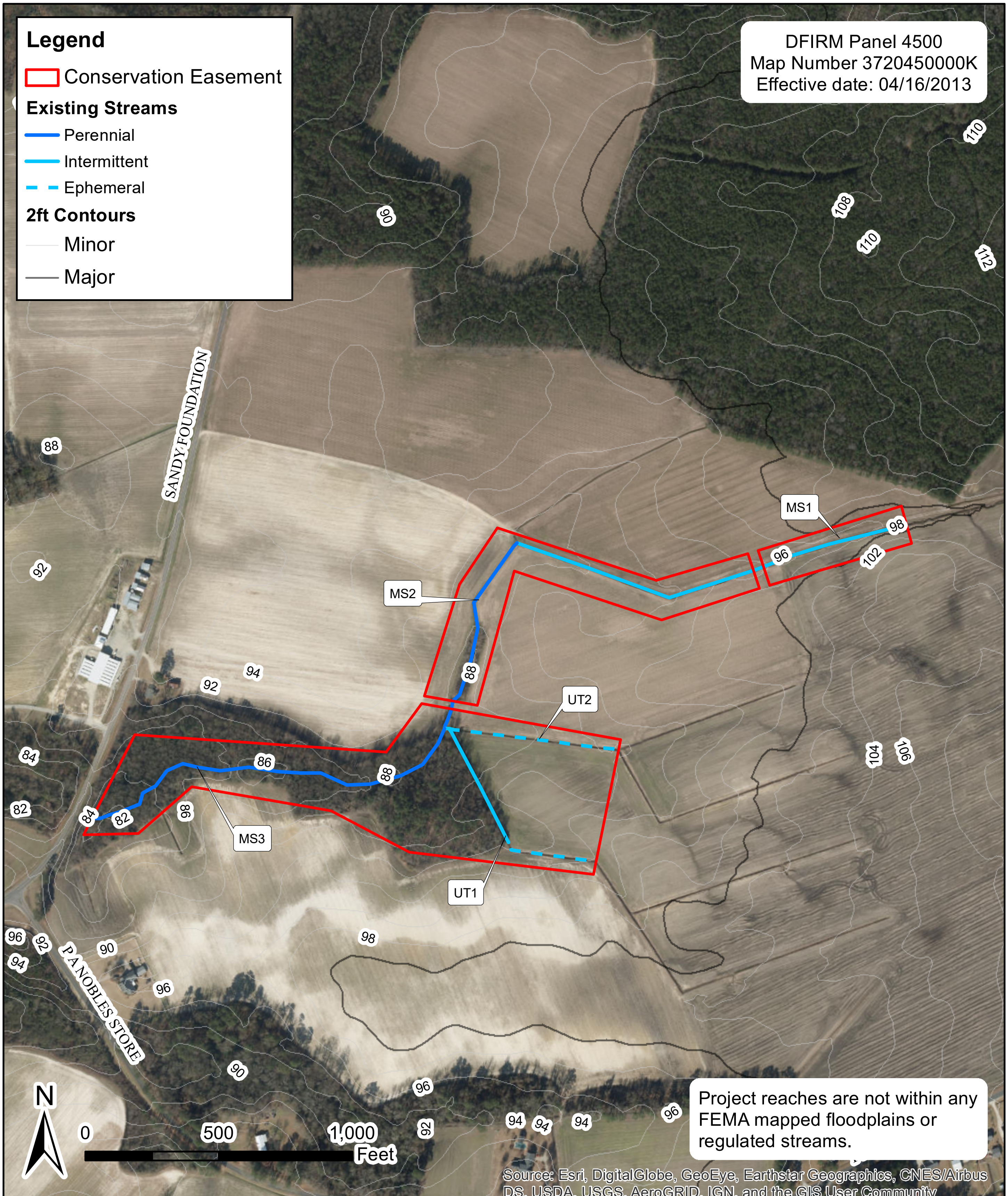
WATER & LAND™ SOLUTIONS

Hornpipe Branch Tributaries Mitigation Project

2019 Aerial Photograph

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE **7d**



WATER & LAND™ SOLUTIONS

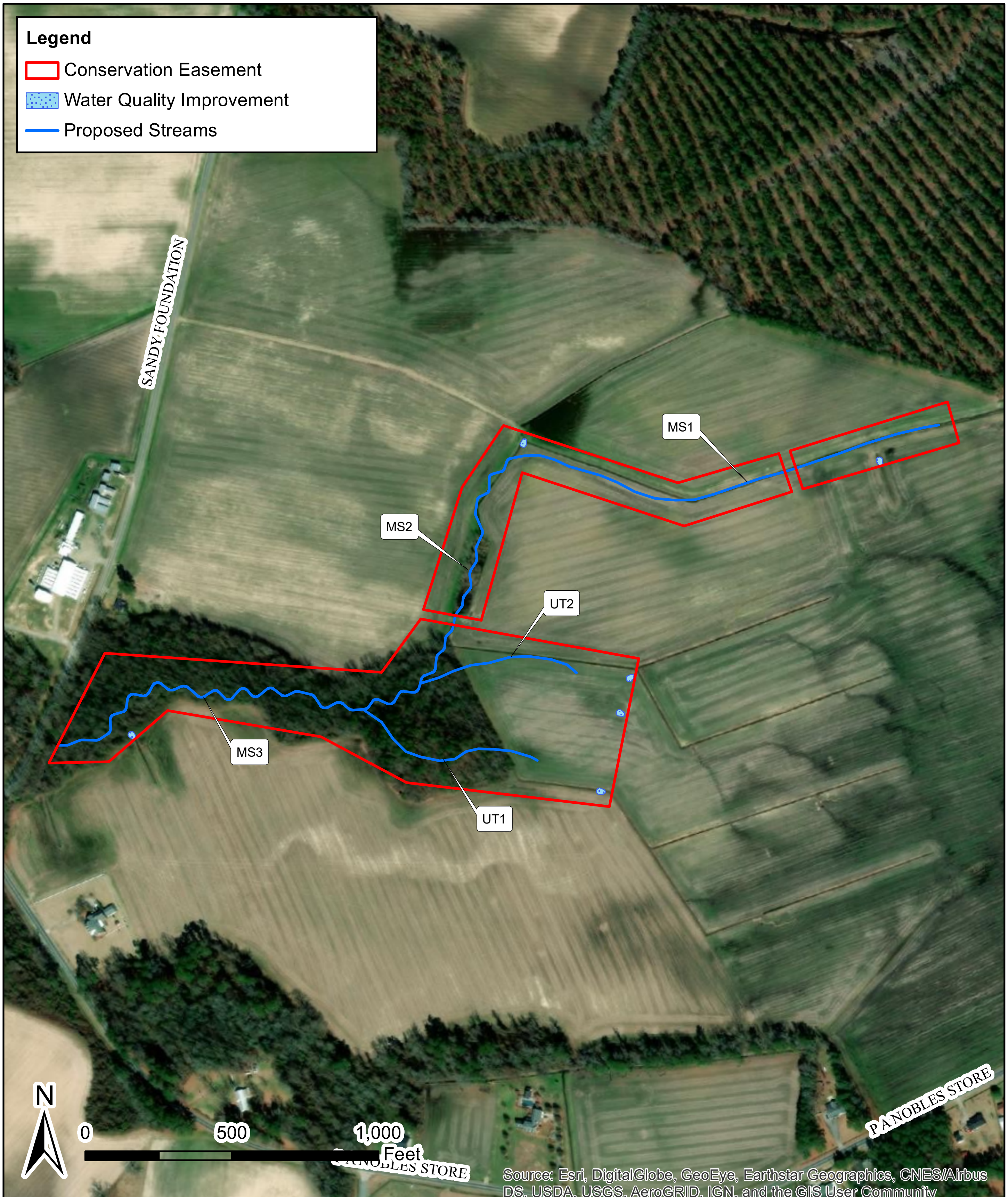
Hornpipe Branch Tributaries Mitigation Project

Floodplain Map

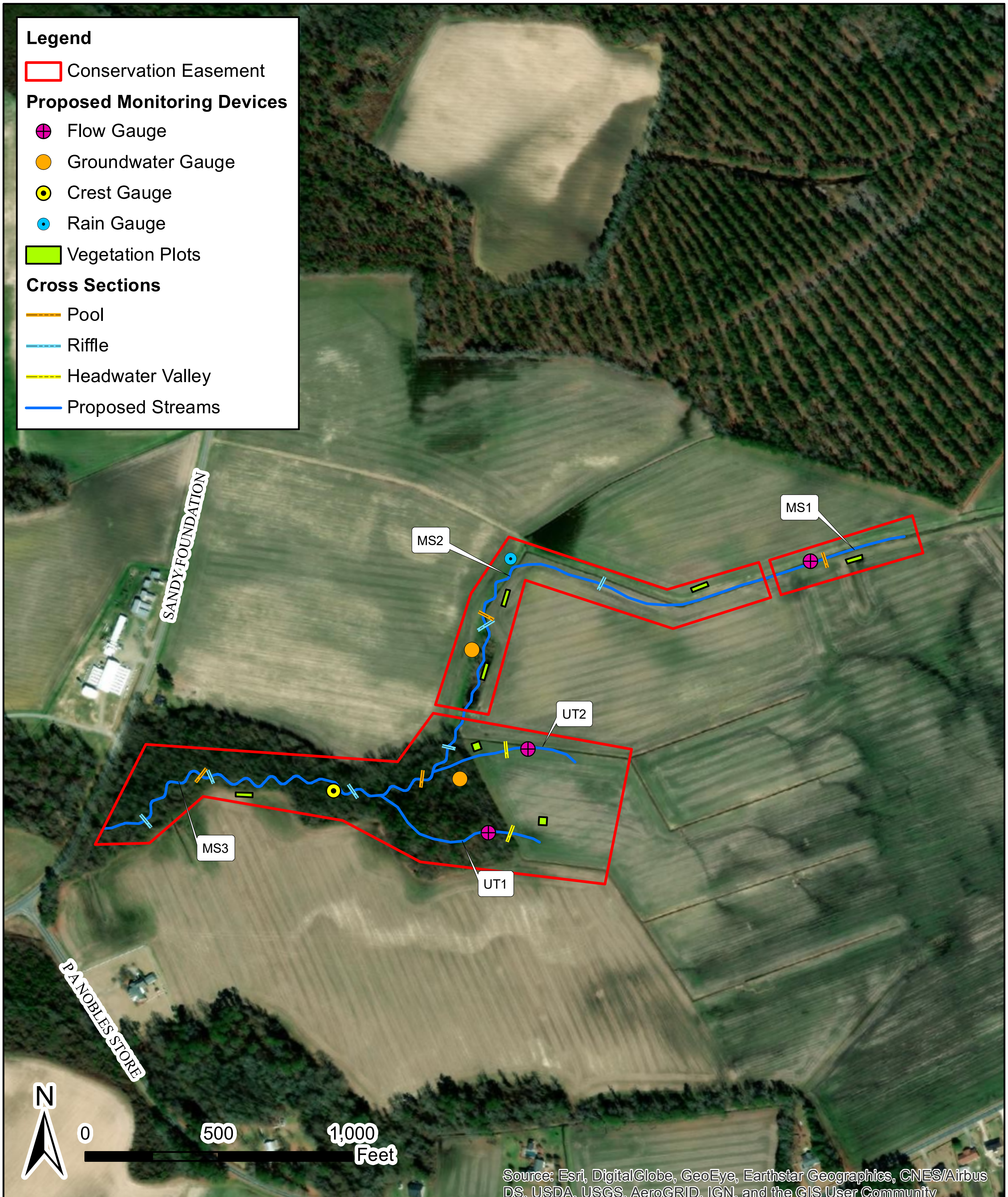
NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE

8



WATER & LAND™ SOLUTIONS	Hornpipe Branch Tributaries Mitigation Project	Proposed Mitigation Features NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US	FIGURE 9



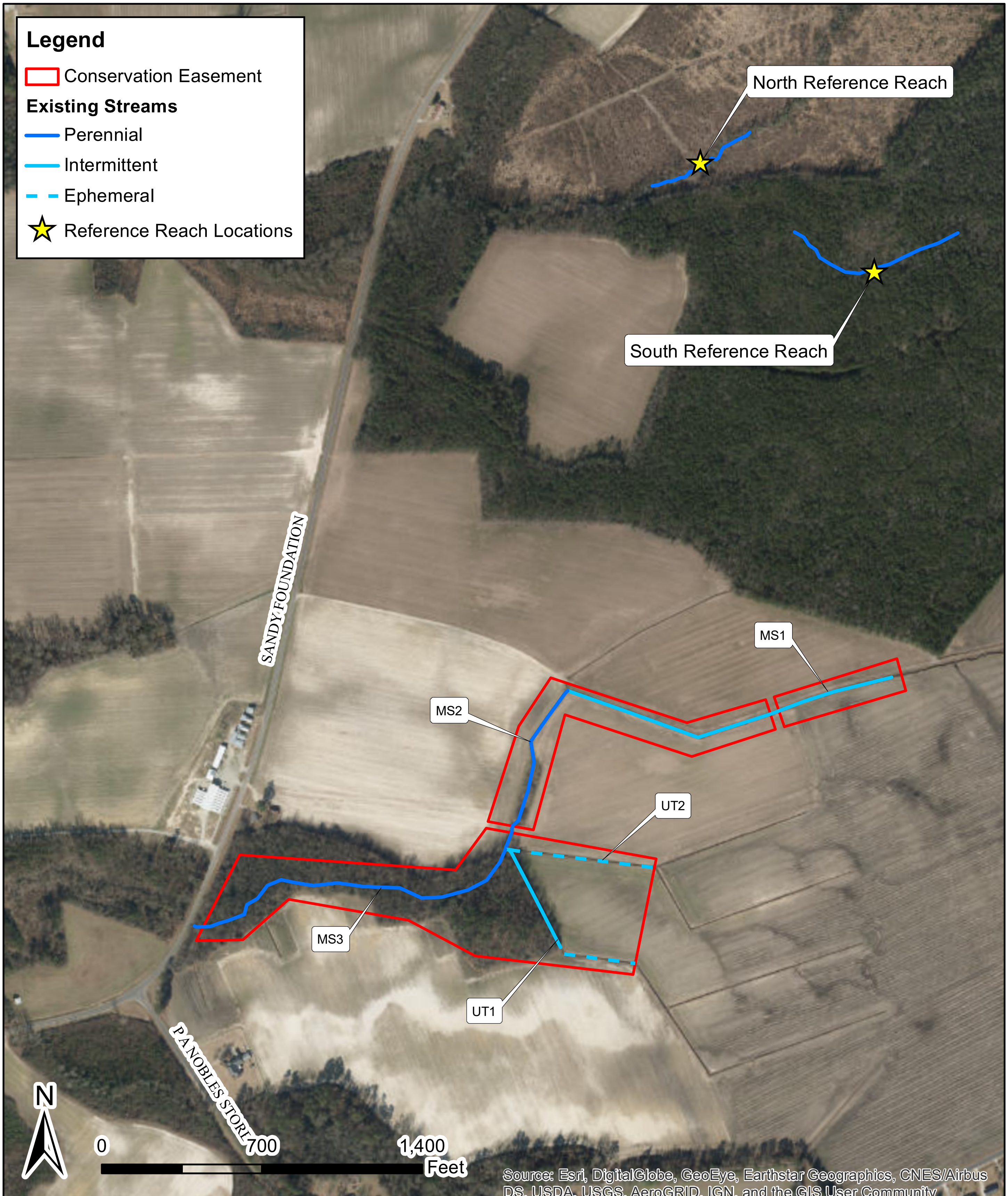
WATER & LAND™ SOLUTIONS

Hornpipe Branch Tributaries Mitigation Project

Proposed Monitoring Features

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE 10



WATER & LAND™ SOLUTIONS

Hornpipe Branch Tributaries Mitigation Project

Reference Reach Map

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE 11

Appendix 1 – Plan Sheets

DEPARTMENT OF ENVIRONMENTAL QUALITY - DIVISION OF MITIGATION SERVICES

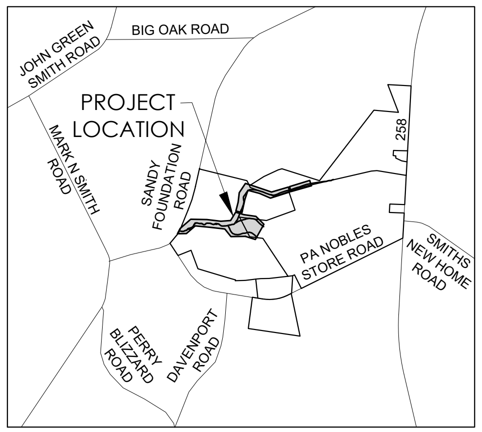
HORNPIPE BRANCH TRIBUTARIES MITIGATION PROJECT

LENOIR COUNTY, NORTH CAROLINA

NCDEQ - DMS PROJECT ID # 100076
NCDEQ - DMS CONTRACT #7605 UNDER RFP 16-007401
NEUSE RIVER BASIN (CU 03020202)
USACE ACTION ID # SAW-2018-01762
TYPE OF WORK : STREAM MITIGATION

VICINITY MAP

N.T.S.

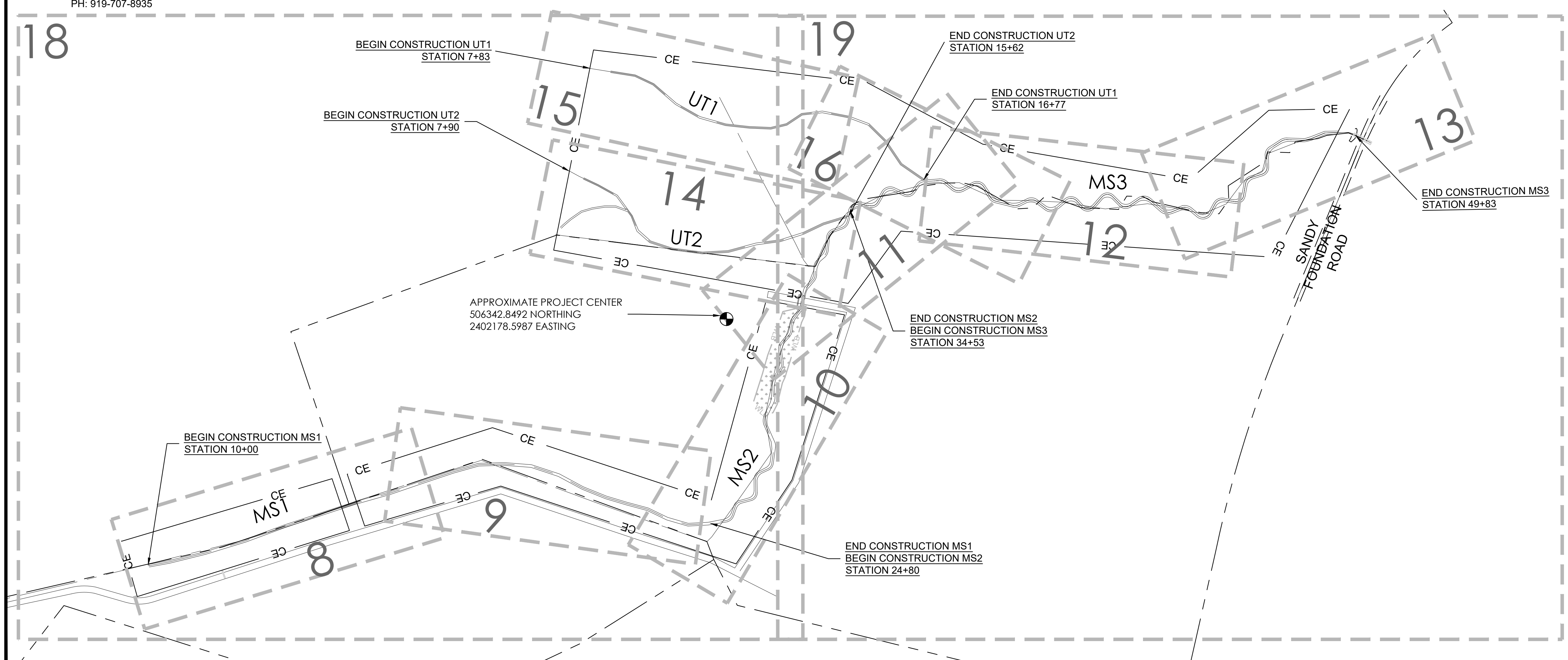


NCDEQ-DMS CONTRACT ADMINISTRATOR:
KRISTIE CORSON
1652 MAIL SERVICE CENTER
RALEIGH, NC 27699-1652
PH: 919-707-8935

PROJECT SUMMARY

Project Reach Designation	Type of Mitigation	Proposed Stream Length (LF)	Mitigation Ratio (X:1)	Proposed Stream Mitigation Credits (SMCs)
MS1	Stream Restoration (PI/PII)	1,440	1	1,440.000
MS2	Stream Restoration (PI)	943	1	943.000
MS3	Stream Restoration (PI/PII)	1,529	1	1,529.000
UT1	Stream Restoration (HW/PI)	677	1	677.000
UT2	Stream Restoration (HW/PI)	562	1	562.000
Total		**5,151**		**5,151.000**

SHEET INDEX



WATER & LAND SOLUTIONS
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(919)614-5111
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PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 36916 ENGINEER CHRISTOPHER A. TOMSIC

PRELIMINARY PLANS NOT FOR CONSTRUCTION

ENGINEERING SERVICES BY
WLS ENGINEERING, PLLC
6 DULA SPRINGS RD.
WEAVERVILLE, NC 28787
FIRM LICENSE NO. P-1480

REVISIONS

NO.	DESCRIPTION	DATE
A	DRAFT MIT PLAN	2-21-20
B	FINAL DRAFT MIT PLAN	4-8-20
C	FINAL MIT PLAN	8-24-20

PROJECT NAME

HORNPIPE BRANCH TRIBUTARIES MITIGATION PROJECT

LENOIR COUNTY, NC

DRAWING INFORMATION

PROJECT NO.	18-006
FILENAME	01_HORNPIPE_COVER.DWG
DESIGNED BY	KMV
DRAWN BY	APL/JNC
DATE	8-24-20
HORIZ. SCALE	1" = 300'
VERT. SCALE	N/A

NORTH

150 75 0 150 300

GRAPHIC SCALE

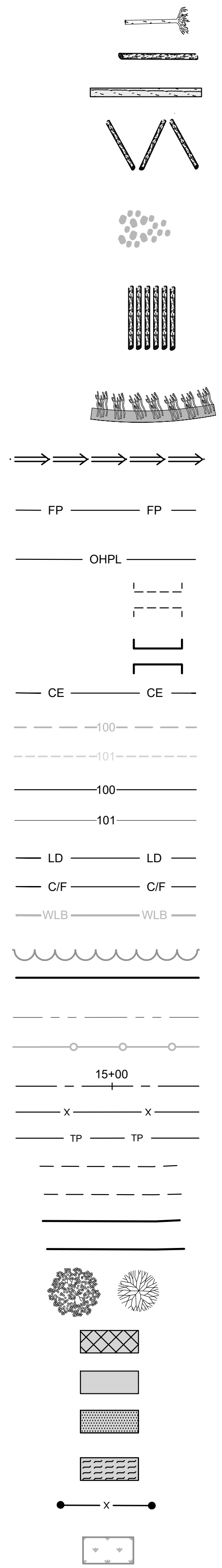
SHEET NAME

COVER SHEET

SHEET NUMBER

1

LEGEND



- ROOTWAD
- LOG VANE
- LOG WEIR
- LOG STEP-POOL
- CONSTRUCTED STONE RIFFLE
- CONSTRUCTED LOG RIFFLE
- GEOLIFT W/ TOEWOOD
- PROPOSED OUTLET CHANNEL
- 100 YEAR FLOOD PLAIN
- EXISTING OVERHEAD ELECTRIC
- TEMPORARY STREAM CROSSING
- PERMANENT STREAM CROSSING
- PROPOSED CONSERVATION EASEMENT BOUNDARY
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- LIMITS OF DISTURBANCE
- CUT/FILL LIMITS
- EXISTING WETLAND BOUNDARY
- EXISTING WOODLINE
- PROPOSED TOP OF STREAM BANK
- EXISTING PROPERTY BOUNDARY
- EXISTING FENCE
- PROPOSED CENTERLINE (THALWEG)
- PROPOSED FIELD FENCE
- PROPOSED TREE PROTECTION FENCE
- EXISTING FARM PATH
- PROPOSED FARM PATH
- EXISTING TREE
- CHANNEL BLOCK
- CHANNEL FILL
- FLOODPLAIN DEPRESSION
- WATER QUALITY TREATMENT FEATURE
- PROPOSED GATE
- EXISTING WETLAND AREA

CONSTRUCTION SEQUENCE

THE ENGINEER WILL PROVIDE CONSTRUCTION OBSERVATION DURING THE CONSTRUCTION PHASE OF THIS PROJECT. THE FOLLOWING CONSTRUCTION SEQUENCE SHALL BE USED DURING PROJECT CONSTRUCTION IMPLEMENTATION. PRIOR TO BEGINNING ANY LAND DISTURBING ACTIVITIES, NOTIFICATION OF AND RECEIPT OF THE CERTIFICATE OF APPROVAL MUST BE RECEIVED FROM NCDEQ -LAND QUALITY SECTION. THE CONTRACTOR SHALL CALL NC DEQ LQS AT 919-791-4200 TO SCHEDULE A PRE-CONSTRUCTION MEETING AT LEAST 72 HOURS PRIOR TO PROJECT ACTIVATION. THE CONTRACTOR SHALL REFER TO THE APPROVED EROSION AND SEDIMENTATION CONTROL PERMIT AND CORRESPONDING PLANS AND TECHNICAL SPECIFICATIONS FOR SPECIFIC CONSTRUCTION SEQUENCING ITEMS AND SHALL BE RESPONSIBLE FOR FOLLOWING THE APPROVED PLANS AND PERMIT CONDITIONS.

1. THE CONTRACTOR SHALL NOTIFY (NC 811) (1-800-632-4949) BEFORE ANY EXCAVATION BEGINS. ANY UTILITIES AND RESPECTIVE EASEMENTS SHOWN ON THE PLANS ARE CONSIDERED APPROXIMATE AND THE CONTRACTOR SHALL NOTIFY THE ENGINEER OF ANY DISCREPANCIES. THE CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL UTILITIES AND ADJOINING EASEMENTS AND SHALL REPAIR OR REPLACE ANY DAMAGED UTILITIES AT HIS/HER OWN EXPENSE.
2. THE CONTRACTOR SHALL PREPARE STABILIZED CONSTRUCTION ENTRANCES, HAUL ROADS AND SHALL MOBILIZE EQUIPMENT, MATERIALS, PREPARE STAGING AREA(S) AND STOCKPILE AREA(S) AS SHOWN ON THE PLANS. HAUL ROADS SHALL BE PROPERLY MAINTAINED AT ALL TIMES DURING CONSTRUCTION.
3. CONSTRUCTION TRAFFIC SHALL BE RESTRICTED TO THE AREA DENOTED AS LIMITS OF DISTURBANCE OR HAUL ROADS AS SHOWN ON THE PLANS.
4. THE CONTRACTOR SHALL INSTALL TEMPORARY ROCK DAMS AT LOCATIONS INDICATED ON THE PLANS.
5. THE CONTRACTOR SHALL INSTALL TEMPORARY SILT FENCE AROUND THE STAGING AREA(S). TEMPORARY SILT FENCING WILL ALSO BE PLACED AROUND THE TEMPORARY STOCKPILE AREAS AS MATERIAL IS STOCKPILED THROUGHOUT THE CONSTRUCTION PERIOD.
6. THE CONTRACTOR SHALL INSTALL ALL TEMPORARY AND PERMANENT STREAM CROSSINGS AS SHOWN ON THE PLANS IN ACCORDANCE WITH THE APPROVED SEDIMENTATION AND EROSION CONTROL PERMIT. THE EXISTING CHANNEL AND DITCHES ON SITE WILL REMAIN OPEN DURING THE INITIAL STAGES OF CONSTRUCTION TO ALLOW FOR DRAINAGE AND TO MAINTAIN SITE ACCESSIBILITY.
7. THE CONTRACTOR SHALL CONSTRUCT ONLY THE PORTION OF CHANNEL THAT CAN BE COMPLETED AND STABILIZED WITHIN THE SAME DAY. THE CONTRACTOR SHALL APPLY TEMPORARY AND PERMANENT SEED AND MULCH TO ALL DISTURBED AREAS AT THE END OF EACH WORK DAY, WITH THE REQUIREMENT OF ESTABLISHING TEMPORARY AND PERMANENT GROUND COVER THROUGH VEGETATION ESTABLISHMENT.
8. THE CONTRACTOR SHALL CLEAR AND GRUB AN AREA ADEQUATE TO CONSTRUCT THE STREAM CHANNEL AND GRADING OPERATIONS AFTER ALL EROSION AND SEDIMENTATION MEASURES HAVE BEEN INSTALLED AND APPROVED. IN GENERAL, THE CONTRACTOR SHALL WORK FROM UPSTREAM TO DOWNSTREAM AND IN-STREAM STRUCTURES AND CHANNEL FILL MATERIAL SHALL BE INSTALLED USING A PUMP-AROUND OR FLOW DIVERSION MEASURE AS SHOWN ON THE PLANS.
9. CONTRACTOR SHALL BEGIN CHANNEL CONSTRUCTION UPSTREAM AND PROCEED IN A DOWNSTREAM DIRECTION WITH CONSTRUCTION. THE DESIGN CHANNEL SHOULD BE CONSTRUCTED OFFLINE AND/OR IN THE DRY WHENEVER POSSIBLE. THE CONTRACTOR SHALL EXCAVATE AND CONSTRUCT THE PROPOSED CHANNEL TO PROPOSED DESIGN GRADES AND SHALL NOT EXTEND EXCAVATION ACTIVITIES ANY CLOSER THAN WITHIN 10 FEET (HORIZONTALLY) OF THE TOP OF EXISTING STREAM BANKS IN ORDER TO PROTECT THE INTEGRITY OF THE EXISTING STREAM CHANNEL UNTIL ABANDONMENT.
10. THE CONTRACTOR WILL CONTINUE CONSTRUCTION BY EXCAVATING CHANNEL FILL MATERIAL. THE CONTRACTOR MAY FILL NON JURISDITRIONAL DITCHES WHICH DO NOT CONTAIN ANY WATER DURING THE GRADING OPERATIONS. ALONG STREAM REACHES EXCAVATED MATERIAL SHOULD BE STOCKPILED IN AREAS SHOWN ON THE PLANS. IN ANY AREAS WHERE EXCAVATION DEPTHS WILL EXCEED 10 INCHES, TOPSOIL SHALL BE HARVESTED, STOCKPILED AND PLACED BACK OVER THESE AREAS TO A MINIMUM DEPTH OF 8 INCHES TO ACHIEVE DESIGN GRADES AND CREATE A SOIL BASE FOR VEGETATION PLANTING ACCORDING TO THE DESIGN PLANS AND CONSTRUCTION SPECIFICATIONS.
11. AFTER EXCAVATING AND CONSTRUCTING THE PROPOSED CHANNEL TO PROPOSED DESIGN GRADES, INSTALL IN-STREAM STRUCTURES, BIOENGINEERING MEASURES, PERMANENT AND TEMPORARY SEEDING AND ALL REQUIRED AMENDMENTS, MULCHING, VEGETATION TRANSPLANTS, TO COMPLETE CHANNEL CONSTRUCTION AND READY THE CHANNEL TO ACCEPT FLOW PER APPROVAL BY THE ENGINEER.
12. STREAM FLOW WILL BE DIVERTED BACK INTO THE CONSTRUCTED CHANNEL ONCE THE RESTORED STREAM CHANNEL AND ASSOCIATED RIPARIAN AREA HAS BEEN STABILIZED, AS DETERMINED BY THE ENGINEER AND IN COMPLIANCE WITH APPROVED PERMIT REQUIREMENTS. ONCE STREAM FLOW IS RETURNED TO A RESTORED STREAM CHANNEL REACH, THE CONTRACTOR SHALL IMMEDIATELY BEGIN PLUGGING, FILLING, AND GRADING THE ASSOCIATED ABANDONED REACH OF STREAM CHANNEL, AS INDICATED ON PLANS, MOVING IN A DOWNSTREAM DIRECTION TO ALLOW FOR POSITIVE AND ADEQUATE DRAINAGE OF THE ABANDONED CHANNEL REACH. STREAM FLOW SHALL NOT BE DIVERTED INTO ANY SECTION OF RESTORED STREAM CHANNEL PRIOR TO THE COMPLETION OF THE CONSTRUCTION OF THAT REACH OF PROPOSED CHANNEL, INCLUDING, BUT NOT LIMITED TO FINAL GRADING, STABILIZATION WITH TEMPORARY AND PERMANENT SEEDING AND ALL REQUIRED AMENDMENTS, MULCHING, VEGETATION TRANSPLANT INSTALLATION, INSTREAM STRUCTURE INSTALLATION, BIOENGINEERING INSTALLATION, AND COIR FIBER MATTING INSTALLATION.
13. THE RESTORED CHANNEL SECTIONS SHALL REMAIN OPEN AT THEIR DOWNSTREAM END TO ALLOW FOR DRAINAGE DURING RAIN EVENTS.
14. ALL GRADING ACTIVITIES ADJACENT TO THE STREAM CHANNEL AND RIPARIAN AREAS SHALL BE COMPLETED PRIOR TO DIVERTING STREAM FLOW INTO THE RESTORED STREAM CHANNEL REACHES. ONCE CONSTRUCTION IS COMPLETED ON A REACH OF PROPOSED STREAM CHANNEL, ADDITIONAL GRADING ACTIVITIES SHALL NOT BE CONDUCTED WITHIN 10 FEET (HORIZONTALLY) OF THE NEWLY RESTORED STREAM CHANNEL BANKS. THE CONTRACTOR SHALL NOT FINALIZE GRADE OR ROUGHEN AREAS WHERE REQUIRED EXCAVATION ACTIVITIES HAVE NOT BEEN COMPLETED.
15. ONCE CONSTRUCTION IS COMPLETE WITHIN A PUMP-AROUND WORK AREA OR CONSTRUCTION WORK PHASE LIMIT, THE CONTRACTOR SHALL APPLY TEMPORARY SEEDING TO ANY AREAS DISTURBED DURING CONSTRUCTION WITHIN HOURS. <u>ALL SLOPES STEEPER THAN 3:1 SHALL BE STABILIZED WITH GROUND COVER AS SOON AS PRACTICABLE WITHIN 7 CALENDAR DAYS. ALL OTHER DISTURBED AREAS AND SLOPES FLATTER THAN 3:1 SHALL BE STABILIZED WITHIN 14 CALENDAR DAYS FROM THE LAST LAND-DISTURBING ACTIVITY.</u>
16. PERMANENT GROUND COVER SHALL BE ESTABLISHED FOR ALL DISTURBED AREAS WITHIN 15 WORKING DAYS OR 90 CALENDAR DAYS (WHICHEVER IS SHORTER) FOLLOWING COMPLETION OF CONSTRUCTION. ALL DISTURBED AREAS SHOULD HAVE ESTABLISHED GROUND COVER PRIOR TO DEMOBILIZATION. REMOVE ANY TEMPORARY STREAM CROSSINGS AND TEMPORARY EROSION CONTROL MEASURES. HAUL ROADS TO BE RESTORED TO A CONDITION EQUAL TO OR BETTER THAN FOUND PRIOR TO CONSTRUCTION.
17. ALL REMAINING DISTURBED AREAS SHALL BE STABILIZED BY TEMPORARY AND PERMANENT SEEDING AND MULCHING BEFORE CONSTRUCTION CLOSEOUT IS REQUESTED AND DEMOBILIZATION CAN OCCUR. ALL WASTE MATERIAL MUST BE REMOVED FROM THE PROJECT SITE.
18. THE CONTRACTOR SHALL TREAT AREAS OF INVASIVE SPECIES VEGETATION THROUGHOUT THE PROJECT AREA ACCORDING TO THE CONSTRUCTION CONTRACT DOCUMENTS, INCLUDING THE APPROVED PERMIT, PLANS AND TECHNICAL SPECIFICATIONS PRIOR TO DEMOBILIZATION.
19. THE CONTRACTOR COMPLETE ALL REMAINING PLANTING ACTIVITIES, INCLUDING SHRUB AND TREE PLANTING, REMAINING TRANSPLANT INSTALLATION, INSTALLATION OF REMAINING BIOENGINEERING MEASURES, AND LIVE STAKE INSTALLATION, ACCORDING TO THE CONSTRUCTION CONTRACT DOCUMENTS, INCLUDING THE APPROVED PERMIT, PLANS AND TECHNICAL SPECIFICATIONS. THE CONTRACTOR SHALL COMPLETE THE RE-FORESTATION PHASE OF THE PROJECT AND CONDUCT REMAINING PERMANENT SEEDING IN ACCORDANCE WITH THE CONSTRUCTION CONTRACT DOCUMENTS, INCLUDING THE APPROVED PERMIT, PLANS AND TECHNICAL SPECIFICATIONS.
20. THE CONTRACTOR SHALL ENSURE THAT THE SITE IS FREE OF TRASH AND LEFTOVER CONSTRUCTION MATERIALS PRIOR TO DEMOBILIZATION FROM THE SITE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OFF-SITE REMOVAL OF ALL TRASH, EXCESS BACKFILL, AND ANY OTHER INCIDENTAL MATERIALS PRIOR TO DEMOBILIZATION OF EQUIPMENT FROM THE SITE. THE DISPOSAL AND STOCKPILE LOCATIONS SELECTED MUST BE APPROVED TO THE ENGINEER AND ANY FEES SHALL BE PAID FOR BY THE CONTRACTOR.

GENERAL NOTES

1. THE PROJECT SITE IS LOCATED APPROXIMATELY ELEVEN MILES SOUTH OF KINSTON IN LENOIR COUNTY, NC (35.134227°, -77.655049°) AS SHOWN ON THE COVER SHEET VICINITY MAP. TO ACCESS THE SITE FROM KINSTON, FOLLOW US-258 SOUTHWEST FOR APPROXIMATELY SEVEN MILES AND TURN SLIGHT RIGHT ONTO SANDY FOUNDATION ROAD FOR APPROXIMATELY 1.0 MILE. ARRIVE AT THE SITE ENTRANCE ON THE RIGHT AND FOLLOW THE FARM ROAD NORTH TO THE SITE BOUNDARY.
2. THE PROJECT SITE BOUNDARIES ARE SHOWN ON THE DESIGN PLANS AS THE PROPOSED CONSERVATION EASEMENT. THE CONTRACTOR SHALL PERFORM ALL RELATED WORK ACTIVITIES WITHIN THE PROJECT SITE BOUNDARIES AND/OR WITHIN THE LIMITS OF DISTURBANCE (LOD). THE PROJECT SITE SHALL BE ACCESSED THROUGH THE DESIGNATED ACCESS POINTS SHOWN ON THE PLANS. THE CONTRACTOR IS RESPONSIBLE FOR MAINTAINING PERMITTED ACCESS THROUGHOUT ALL CONSTRUCTION ACTIVITIES.
3. THE CONTRACTOR SHALL TAKE ALL NECESSARY PRECAUTIONS AND MEASURES TO PROTECT ALL PROPERTIES FROM DAMAGE. THE CONTRACTOR SHALL REPAIR ALL DAMAGE CAUSED BY HIS/HER OPERATIONS TO ALL PUBLIC AND PRIVATE PROPERTY AND LEAVE THE PROPERTY IN GOOD CONDITION AND/OR AT LEAST EQUIVALENT TO THE PRE-CONSTRUCTION CONDITIONS. UPON COMPLETION OF ALL CONSTRUCTION ACTIVITIES, THE AREA IS TO BE RESTORED TO A CONDITION EQUAL TO OR BETTER THAN FOUND PRIOR TO CONSTRUCTION.
4. THE TOPOGRAPHIC BASE MAP WAS DEVELOPED USING SURVEY DATA COLLECTED BY LDSI, INC. IN THE WINTER OF 2019. THE HORIZONTAL DATUM WAS TIED TO NAD83 NC STATE PLANE COORDINATE SYSTEM, US SURVEY FEET AND NAVD88 VERTICAL DATUM USING VRS NETWORK AND NCGS MONUMENT. IT IS POSSIBLE THAT EXISTING ELEVATIONS AND SITE CONDTIONS MAY HAVE CHANGED SINCE THE ORIGINAL SURVEY WAS COMPLETED DUE TO EROSION, AND/OR SEDIMENT ACCRETION. IT IS THE CONTRACTOR'S RESPONSIBILITY TO CONFIRM EXISTING GRADES AND ADJUST QUANTITIES, EARTHWORK, AND WORK EFFORTS AS NECESSARY.
5. THE CONTRACTOR SHALL VISIT THE CONSTRUCTION SITE AND THOROUGHLY FAMILIARIZE HIM/HERSELF WITH ALL EXISTING CONDITIONS. PRIOR TO BEGINNING CONSTRUCTION. THE CONTRACTOR SHALL VERIFY THE ACCURACY AND COMPLETENESS OF THE CONSTRUCTION SPECIFICATIONS AND DESIGN PLANS REGARDING THE NATURE AND EXTENT OF THE WORK DESCRIBED.
6. THE CONTRACTOR SHALL BRING ANY DISCREPANCIES BETWEEN THE CONSTRUCTION PLANS AND SPECIFICATIONS AND/OR FIELD CONDITIONS TO THE ATTENTION OF THE SPONSORS ENGINEER BEFORE CONSTRUCTION BEGINS.
7. THERE SHALL BE NO CLEARING OR REMOVAL OF ANY NATIVE SPECIES VEGETATION OR TREES OF SIGNIFICANCE, OTHER THAN THOSE INDICATED ON THE PLANS OR AS DIRECTED BY THE ENGINEER.
8. THE CONTRACTOR SHALL EXERCISE CARE DURING GRADING ACTIVITIES IN THE VICINITY OF NATIVE VEGETATION AND TREES OF SIGNIFICANCE AT THE CONSTRUCTION SITE. ALL GRADING IN THE VICINITY OF TREES NOT IDENTIFIED FOR REMOVAL SHALL BE MADE IN A MANNER THAT DOES NOT DISTURB THE ROOT SYSTEM WITHIN THE DRIP LINE OF THE TREE.
9. WORK ACTIVITIES ARE BEING PERFORMED AS AN ENVIRONMENTAL RESTORATION PLAN NEAR PRIVATE RESIDENCES. THE CONTRACTOR SHALL MAKE ALL REASONABLE EFFORTS TO REDUCE SEDIMENT LOSS, PROTECT PUBLIC SAFETY, AND MINIMIZE DISTURBANCE OF THE SITE WHILE PERFORMING THE CONSTRUCTION WORK. ALL AREAS SHALL BE KEPT NEAT, CLEAN, AND FREE OF ALL TRASH AND DEBRIS, AND ALL REASONABLE PRECAUTIONS SHALL BE TAKEN TO AVOID DAMAGE TO EXISTING ROADS, VEGETATION, TURF, STRUCTURES, AND PRIVATE PROPERTY.
10. PRIOR TO START OF WORK, THE CONTRACTOR SHALL SUBMIT THE SOURCE OF MATERIALS, INCLUDING AGGREGATES, EROSION CONTROL MATTING, WOOD AND NATIVE PLANTING MATERIAL TO THE ENGINEER FOR REVIEW AND APPROVAL. NO WORK SHALL BE PERFORMED UNTIL THE SOURCE OF MATERIAL IS APPROVED BY THE ENGINEER.
11. THE CONTRACTOR SHALL BE HELD SOLELY RESPONSIBLE FOR ANY NECESSARY COORDINATION BETWEEN THE VARIOUS COUNTY, STATE OR FEDERAL AGENCIES, UTILITY COMPANIES, HIS/HER SUB-CONTRACTORS, AND THE ENGINEER FOR THE DURATION OF THE PROJECT.
12. PRIOR TO START OF WORK, THE CONTRACTOR SHALL SUBMIT THEIR DETAILED PLANTING SCHEDULE TO THE ENGINEER FOR REVIEW. NO WORK SHALL BE PERFORMED UNTIL THIS SCHEDULE IS APPROVED BY THE ENGINEER. THE DETAILED PLANTING SCHEDULE SHALL CONFORM TO THE PLANTING REVEGETATION PLAN AND SHALL INCLUDE A SPECIES LIST AND TIMING SEQUENCE.
13. THE CONTRACTOR IS REQUIRED TO INSTALL IN-STREAM STRUCTURES AND CULVERT PIPES USING A BACKHOE/EXCAVATOR WITH A HYDRAULIC THUMB OF SUFFICIENT SIZE TO PLACE STRUCTURES AND MATERIALS INCLUDING LOGS, STONE, AND TEMPORARY WOOD MAT STREAM CROSSINGS.

GRADING NOTES

1. NO GRADING ACTIVITIES SHALL OCCUR BEYOND THE PROJECT LIMITS OF DISTURBANCE (LOD) AS SHOWN ON THE EROSION AND SEDIMENT CONTROL PLANS.
2. ONCE DESIGN GRADES ARE ACHIEVED AS SHOWN ON THE PLAN AND PLAN AND PROFILE, THE HEADWATER VALLEY, STREAM AND WETLAND, AND FLOODPLAIN AREAS SHALL BE ROUGHENED USING TECHNIQUES DESCRIBED IN THE CONSTRUCTION SPECIFICATIONS.
3. ALL SUITABLE SOIL MATERIAL REQUIRED TO FILL AND/OR PLUG EXISTING DITCHES AND/OR STREAM CHANNEL SHALL BE GENERATED ON-SITE AS DESCRIBED IN THE CONSTRUCTION SPECIFICATIONS. ANY EXCESS SPOIL MATERIAL SHALL BE STOCKPILED IN DESIGNATED AREAS AND OR HAULED OFF-SITE AS APPROVED BY THE ENGINEER.

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WEAVERVILLE, NC 28787
FIRM LICENSE NO. P-1480

REVISIONS

NO.	DESCRIPTION	DATE
A	DRAFT MIT PLAN	2-21-20
B	FINAL DRAFT MIT PLAN	4-8-20
C	FINAL MIT PLAN	8-24-20

PROJECT NAME

HORNPIPE BRANCH TRIBUTARIES MITIGATION PROJECT

LENOIR COUNTY, NC

DRAWING INFORMATION

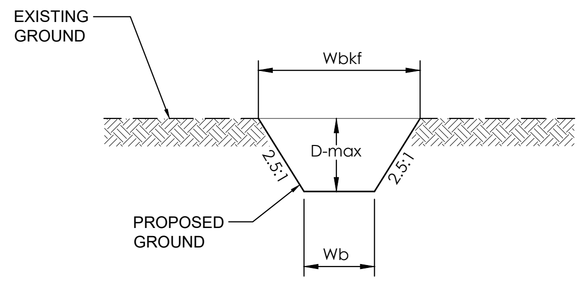
PROJECT NO.	18-006
FILENAME	02_HORNPIPE_GENERAL NOTES.DWG
DESIGNED BY	KMV
DRAWN BY	APL/JNC
DATE	8-24-20
HORIZ. SCALE	N.T.S.
VERT. SCALE	N/A

SHEET NAME

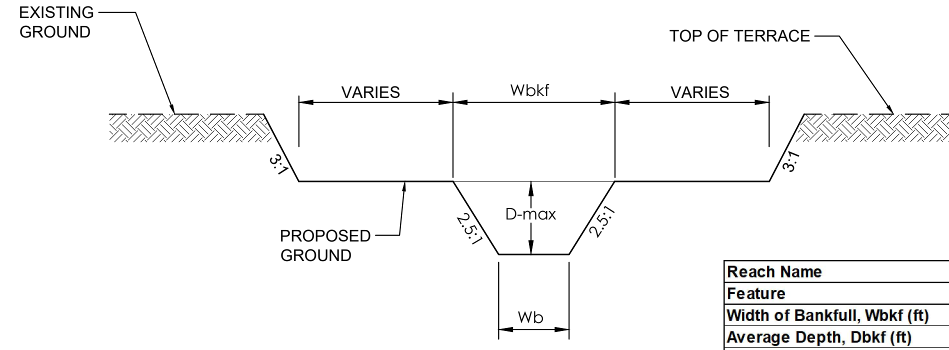
LEGEND/ CONSTRUCTION SEQUENCE/ GENERAL NOTES

SHEET NUMBER

2

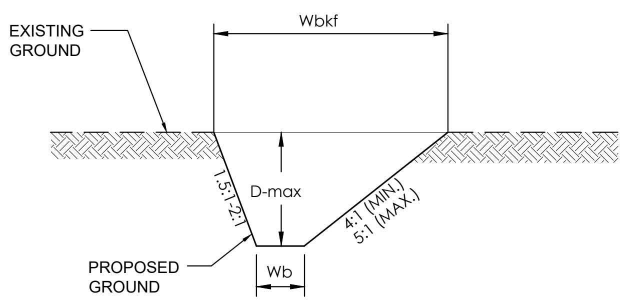


RIFFLE
N.T.S

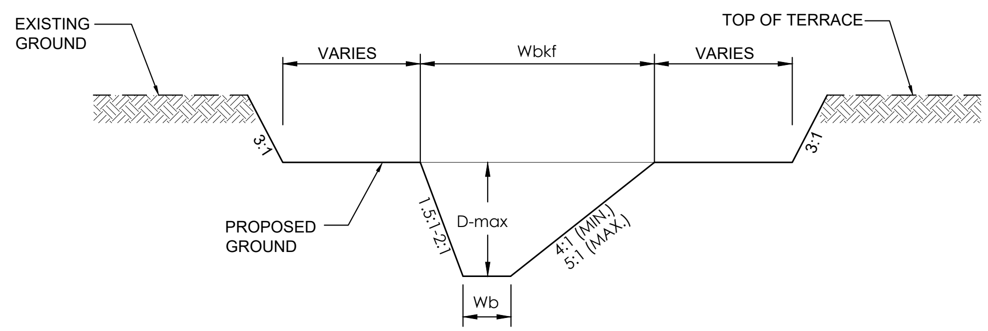


RIFFLE WITH BANKFULL BENCH
N.T.S

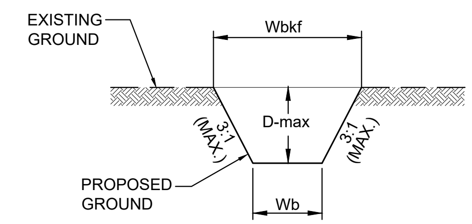
Reach Name	MS1		MS2		MS3		UT1 (HW)		UT2 (HW)		WQ BMP
Feature	Riffle	Pool	Riffle	Pool	Riffle	Pool	Riffle	Pool	Riffle	Pool	Outlet Channel
Width of Bankfull, Wbkf (ft)	6.9	8.3	7.5	9.8	8.4	10.9	4.4	5.7	4.4	5.7	3.5
Average Depth, Dbkf (ft)	0.5	0.7	0.6	0.8	0.6	0.8	0.3	0.4	0.3	0.4	N/A
Maximum Depth, D-Max (ft)	0.7	1.2	0.8	1.3	0.9	1.5	0.3	0.7	0.3	0.7	0.3
Width to Depth Ratio, bkf W/D	13.0	12.2	13.0	12.5	13.0	13.1	16.0	12.9	16.0	12.9	N/A
Bankfull Area, Abkf (sq ft)	3.7	5.6	4.3	7.7	5.4	9.0	1.2	2.5	1.2	2.5	N/A
Bottom Width, Wb (ft)	3.3	1.1	3.6	2.0	4.0	1.2	2.7	1.5	2.7	1.5	1.5



POOL
N.T.S

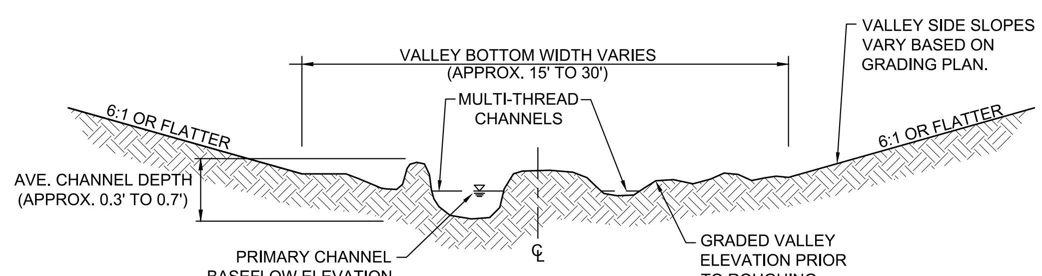


POOL WITH BANKFULL BENCH
N.T.S

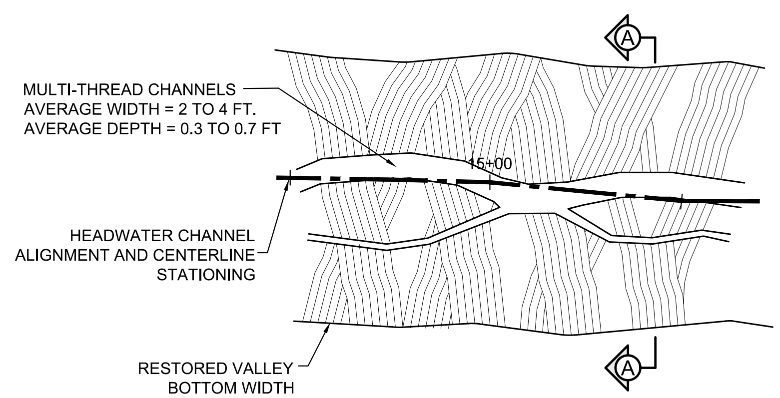


OUTLET CHANNEL
N.T.S

SINGLE-THREAD CHANNEL



SECTION A-A



PLAN VIEW OF CHANNEL PATTERN

HEADWATER (MULTI-THREAD) CHANNEL
NOT TO SCALE

NOTES:

1. GRADE VALLEY AND BOTTOM WIDTH TO DESIGN CONTOURS AS SHOWN ON GRADING PLAN.
2. MICROTOPOGRAPHY IS GRADED USING STANDARD TILLAGE EQUIPMENT TO CREATE MOUNDS AND FURROWS AS DESCRIBED IN THE SPECIFICATIONS. ALTERNATIVE CONSTRUCTION METHODS SHALL BE APPROVED BY THE ENGINEER PRIOR TO CONSTRUCTION.
3. THE HEADWATER CHANNEL ALIGNMENT SHALL BE APPROVED BY ENGINEER FOLLOWING COMPLETION OF THE MICROTOPOGRAPHY ROUGHENING.
4. HEADWATER (MULTI-THREAD) CHANNELS WILL BE SHAPED TO FORM SMOOTH TRANSITIONS.
5. UPON COMPLETION OF THE HEADWATER CHANNEL FEATURES, APPLY MULCH, TEMPORARY SEED AND PERMANENT SEED TO THE CONSTRUCTED VALLEY IN ACCORDANCE WITH THE TECHNICAL SPECIFICATIONS.

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PROJECT NAME

HORNPIPE BRANCH TRIBUTARIES MITIGATION PROJECT

LENOIR COUNTY, NC

DRAWING INFORMATION

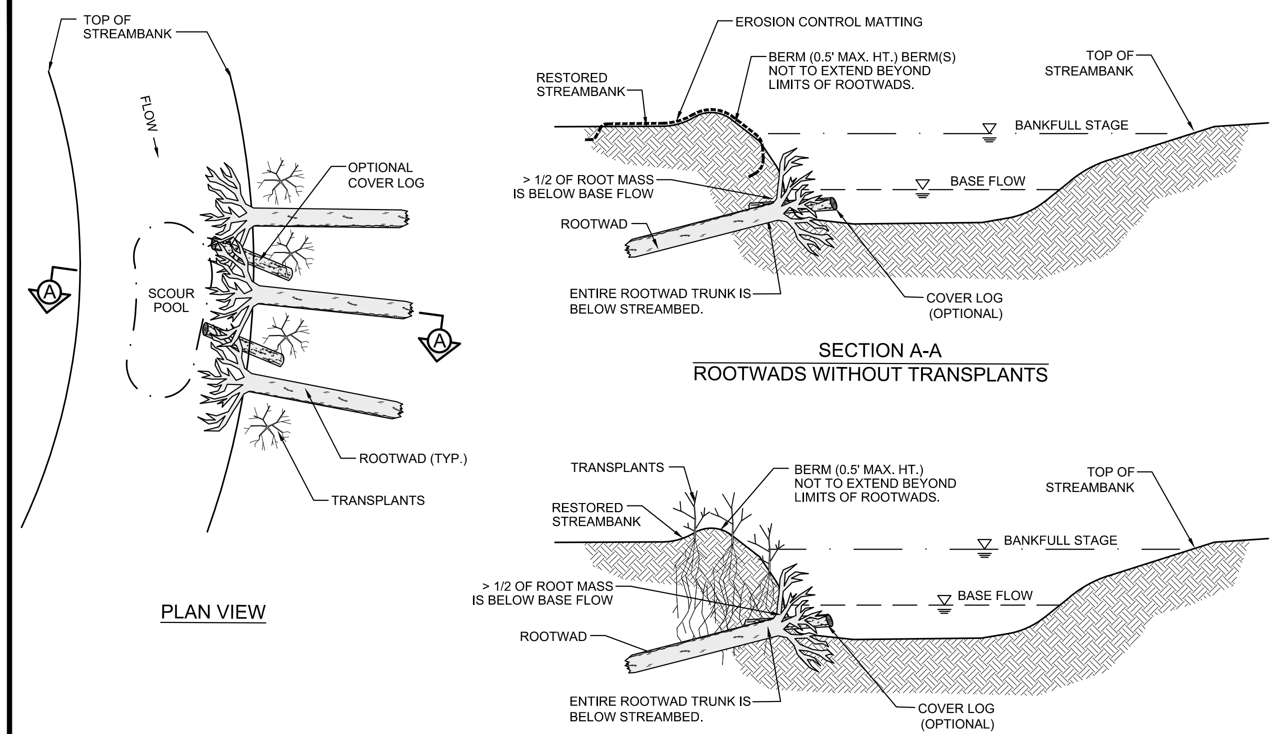
PROJECT NO.	18-006
FILENAME	03_HORNPIPE_TYPICAL_SECTIONS.DWG
DESIGNED BY	KMV
DRAWN BY	APL/JNC
DATE	8-24-20
HORIZ. SCALE	N.T.S.
VERT. SCALE	N/A

SHEET NAME

TYPICAL SECTIONS

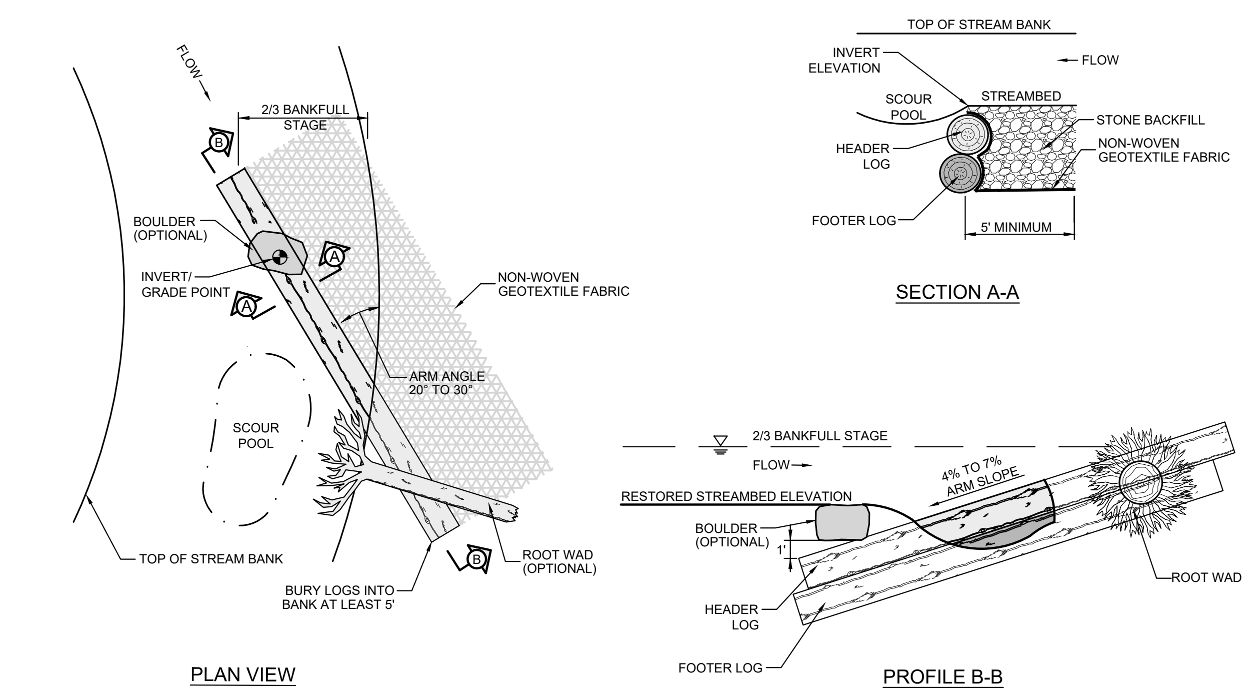
SHEET NUMBER

3



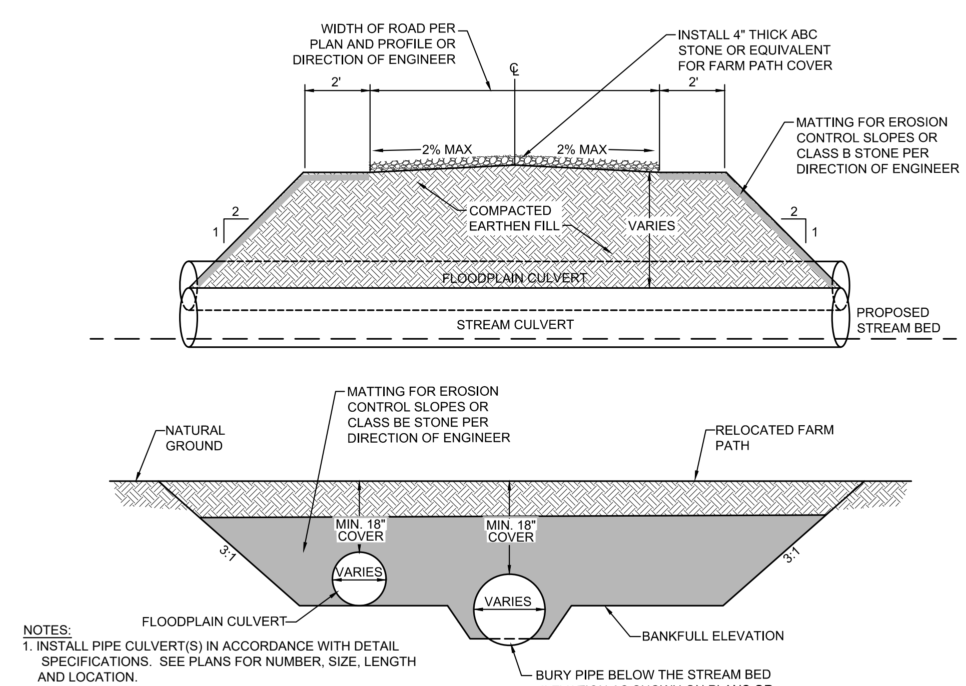
NOTES:
1. THE TRENCHING METHOD REQUIRES THAT A TRENCH BE EXCAVATED FOR THE LOG PORTION OF THE ROOTWAD. A COVER LOG SHOULD BE INSTALLED UNDERNEATH THE ROOTWAD IN A TRENCH EXCAVATED PERPENDICULAR TO THE BANK AND BELOW THE RESTORED STREAMBED. ONE-THIRD OF THE ROOTWAD SHOULD REMAIN BELOW NORMAL BASE FLOW CONDITIONS.

ROOTWADS
NOT TO SCALE



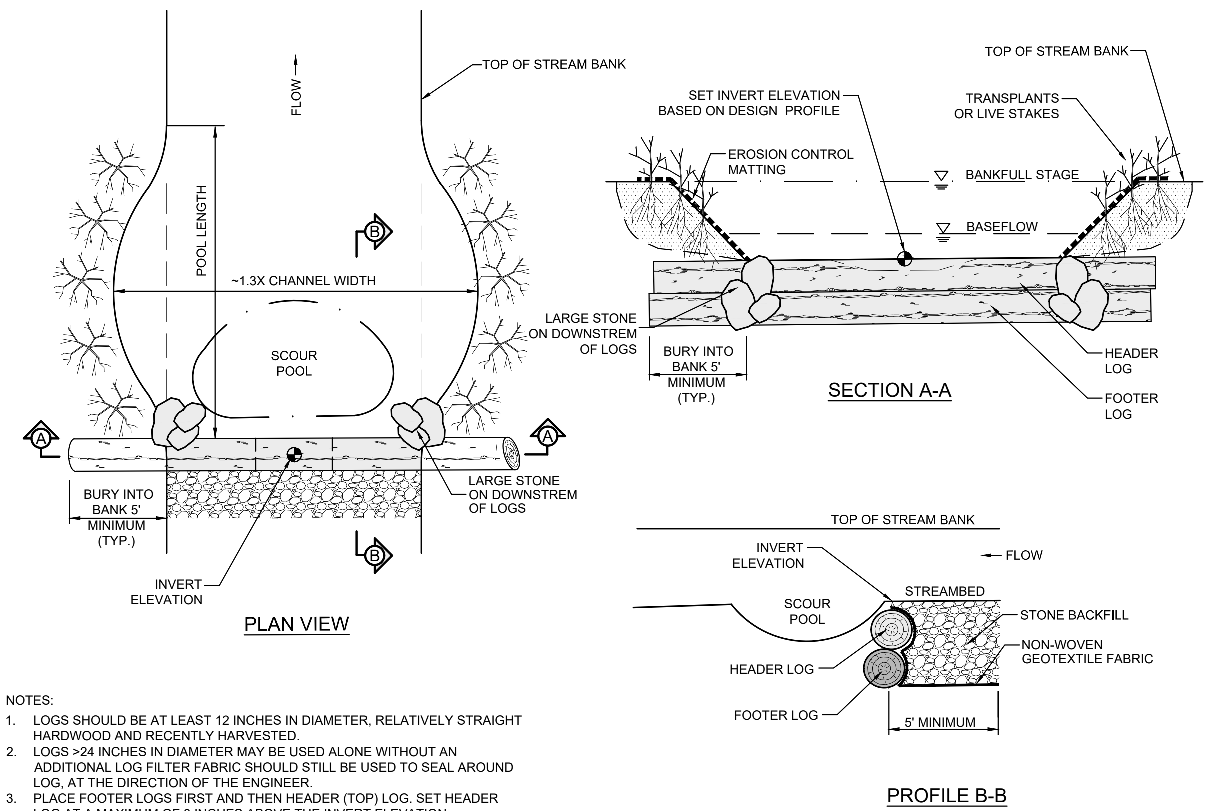
NOTES:
1. LOGS SHOULD BE AT LEAST 10" IN DIAMETER, RELATIVELY STRAIGHT, HARDWOOD, AND RECENTLY HARVESTED.
2. SOIL SHOULD BE COMPACTED WELL AROUND BURIED PORTIONS OF LOGS.
3. ROOTWADS SHOULD BE PLACED BENEATH THE HEADER LOG AND PLACED SO THAT IT LOCKS THE HEADER LOG INTO THE BANK. SEE ROOTWAD DETAIL.
4. BOULDERS OF SUFFICIENT SIZE CAN PLACED ON TOP OF HEADER LOG FOR ANCHORING, PER DIRECTION OF ENGINEER.
5. LOGS SHOULD BE BURIED INTO THE STREAM BED AND BANKS AT LEAST 5 FEET.
6. GEOTEXTILE FABRIC SHOULD BE NAILED TO THE LOG BELOW THE BACKFILL.
7. TRANSPLANTS CAN BE USED INSTEAD OF ROOTWADS, PER DIRECTION OF ENGINEER.

LOG VANE
NOT TO SCALE



NOTES:
1. INSTALL PIPE CULVERT(S) IN ACCORDANCE WITH DETAIL SPECIFICATIONS. SEE PLANS FOR NUMBER, SIZE, LENGTH AND LOCATION.
2. INSTALL COIR FIBER MATTING FOR EROSION CONTROL ALONG FILL SLOPES IN ACCORDANCE WITH DETAIL SPECIFICATIONS.
3. PIPE CULVERTS ARE TO BE A MINIMUM OF 18" COVER AND SPACING IN ACCORDANCE WITH DETAIL SPECIFICATIONS.

PERMANENT CULVERT STREAM CROSSING
NOT TO SCALE



NOTES:
1. LOGS SHOULD BE AT LEAST 12 INCHES IN DIAMETER, RELATIVELY STRAIGHT HARDWOOD AND RECENTLY HARVESTED.
2. LOGS >24 INCHES IN DIAMETER MAY BE USED ALONE WITHOUT AN ADDITIONAL LOG FILTER FABRIC SHOULD STILL BE USED TO SEAL AROUND LOG, AT THE DIRECTION OF THE ENGINEER.
3. PLACE FOOTER LOGS FIRST AND THEN HEADER (TOP) LOG. SET HEADER LOG AT A MAXIMUM OF 3 INCHES ABOVE THE INVERT ELEVATION.
4. CUT A NOTCH IN THE HEADER LOG APPROXIMATELY 30% OF THE CHANNEL BOTTOM WIDTH AND EXTENDING DOWN TO THE INVERT ELEVATION. NOTCH SHALL BE USED TO CENTER FLOW AND NOT EXCEED 3 INCHES IN DEPTH.
5. USE GEOTEXTILE FABRIC FOR DRAINAGE TO SEAL GAPS BETWEEN LOGS.
6. INSTALL VEGETATION TRANSPLANTS FROM TOE OF STREAM BANK TO TOP OF STREAM BANK.
7. SEE TYPICAL SECTION FOR CHANNEL DIMENSIONS.

LOG WEIR
NOT TO SCALE

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PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 36916 ENGINEER CHRISTOPHER A. TOMSIC

PRELIMINARY PLANS NOT FOR CONSTRUCTION

ENGINEERING SERVICES BY WLS ENGINEERING, PLLC 6 DULA SPRINGS RD. WEAVERVILLE, NC 28787 FIRM LICENSE NO. P-1480

REVISIONS

NO.	DESCRIPTION	DATE
A	DRAFT MIT PLAN	2-21-20
B	FINAL DRAFT MIT PLAN	4-8-20
C	FINAL MIT PLAN	8-24-20

PROJECT NAME

HORNPIPE BRANCH TRIBUTARIES MITIGATION PROJECT

LENOIR COUNTY, NC

DRAWING INFORMATION

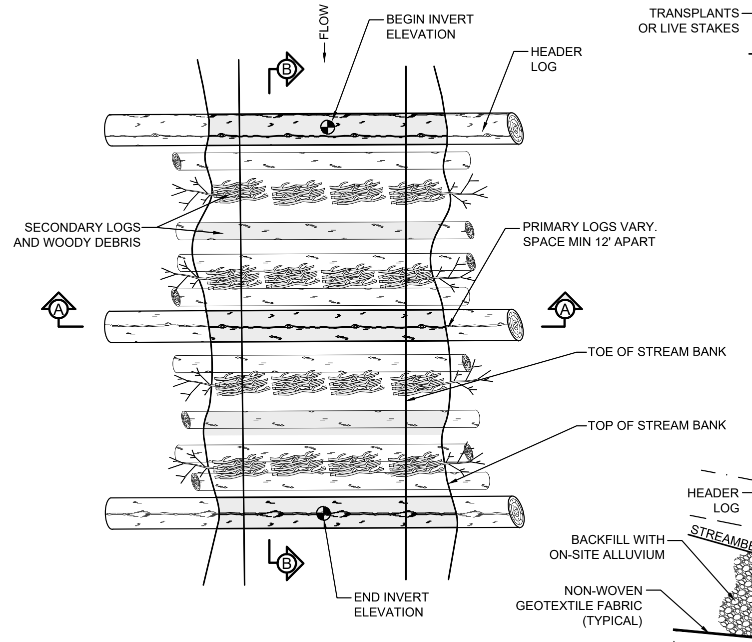
PROJECT NO.	18-006
FILENAME	04-07_HORNPIPE_DETAIL_SHEETS.DWG
DESIGNED BY	KMV
DRAWN BY	APL/JNC
DATE	8-24-20
HORIZ. SCALE	N.T.S.
VERT. SCALE	N/A

SHEET NAME

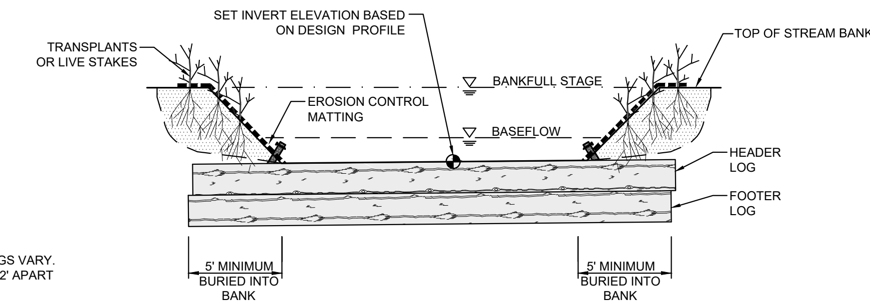
DETAILS

SHEET NUMBER

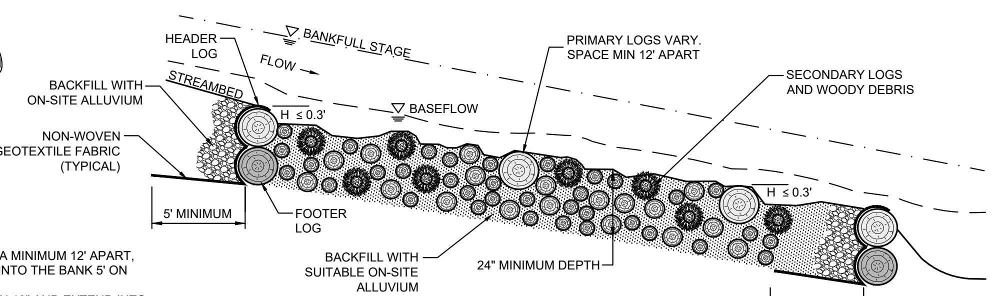
4



PLAN VIEW



SECTION A-A

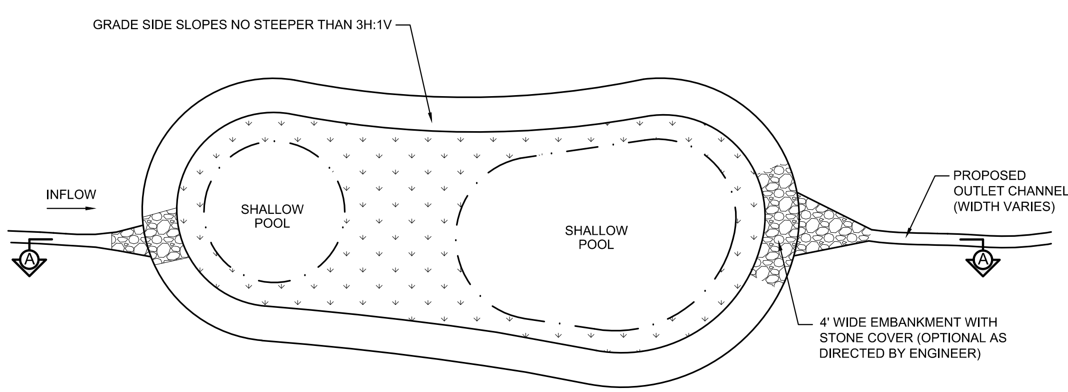


PROFILE B-B

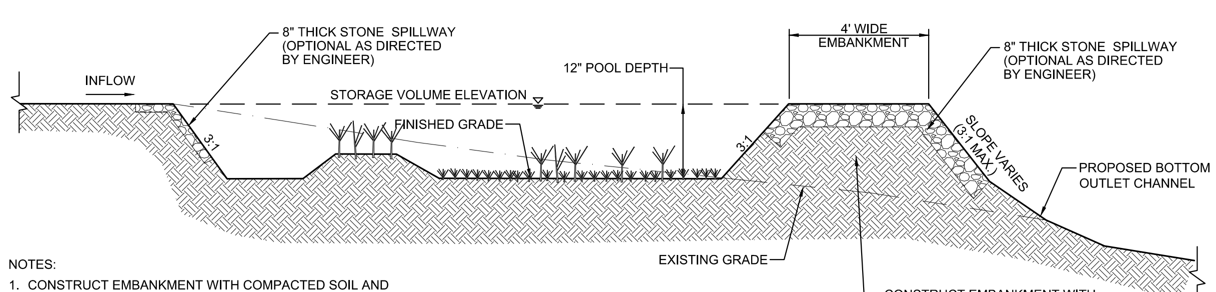
NOTES:
1. PRIMARY LOGS SHOULD BE AT LEAST 12" OR MORE IN DIAMETER AND SPACED A MINIMUM 12' APART, RELATIVELY STRAIGHT, HARDWOOD, RECENTLY HARVESTED AND EXTENDING INTO THE BANK 5' ON EACH SIDE OF STREAM BANK.
2. SECONDARY LOGS SHOULD BE AT LEAST 4" IN DIAMETER AND NO LARGER THAN 10" AND EXTEND INTO THE BANK 3' ON EACH SIDE. WOODY DEBRIS MATERIAL SHALL BE VARYING DIAMETER TO ALLOW MATERIAL TO BE COMPACTED.
3. NON-WOVEN GEOTEXTILE FABRIC SHOULD BE NAILED TO THE HEADER LOG BELOW THE BACKFILL.
4. ROOT WADS CAN BE USED INSTEAD OF TRANSPLANTS OR LIVE STAKES PER DIRECTION OF ENGINEER.
5. AFTER TRENCH HAS BEEN EXCAVATED A LAYER OF SECONDARY LOGS AND WOODY DEBRIS SHOULD BE PLACED WITH MINIMAL GAPS. A LAYER OF ON-SITE ALLUVIUM SHOULD BE APPLIED TO FILL VOIDS BETWEEN SECONDARY LOGS BEFORE ADDITIONAL LAYERS ARE PLACED.
6. SEE TYPICAL SECTION FOR CHANNEL DIMENSIONS.

CONSTRUCTED LOG RIFFLE

NOT TO SCALE



PLAN VIEW



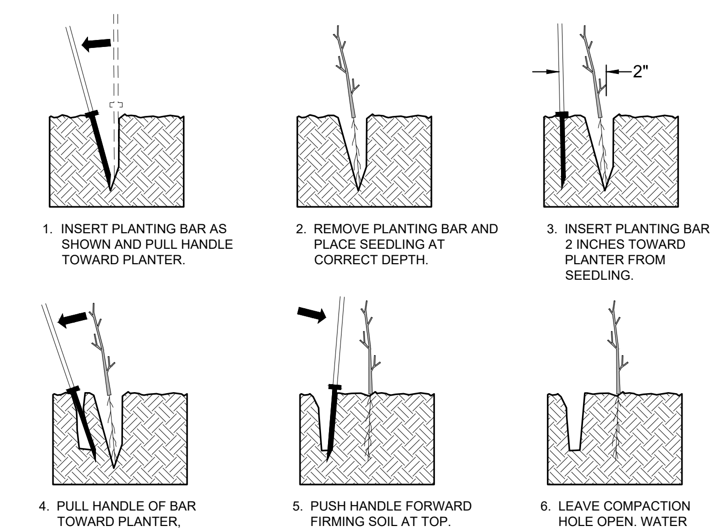
NOTES:
1. CONSTRUCT EMBANKMENT WITH COMPACTED SOIL AND SUITABLE MATERIAL IN ACCORDANCE WITH TECHNICAL SPECIFICATIONS.
2. WATER QUALITY TREATMENT FEATURE VARIES IN SIZE AND SHAPE AS SHOWN ON PLANS.
3. PLANT APPROPRIATE WETLAND SPECIES VEGETATION AS SPECIFIED IN THE PLANTING PLAN.

SECTION A - A

WATER QUALITY TREATMENT FEATURE

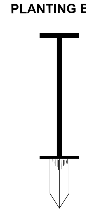
NOT TO SCALE

PLANTING METHOD USING THE PLANTING BAR



NOTES:
1. PLANT BARE ROOT VEGETATION TO THE WIDTH OF THE BUFFER/PLANTING ZONE AS SHOWN ON THE PLANS.
2. ALLOW FOR 8-15 FEET SPACING BETWEEN PLANTINGS, AS DEFINED IN THE TECHNICAL SPECIFICATIONS.
3. LOOSEN COMPACTED SOIL.
4. PLANT IN HOLES MADE BY A MATTOCK, DIBBLE, PLANTING BAR OR OTHER APPROVED MEANS.
5. PLANT IN HOLES DEEP AND WIDE ENOUGH TO ALLOW THE ROOTS TO SPREAD OUT AND DOWN WITHOUT J-ROOTING.
6. KEEP ROOTS MOIST WHILE DISTRIBUTING OR WAITING TO PLANT BY MEANS OF WET CANVAS, BURLAP OR STRAW.
7. HEEL-IN PLANTS IN MOIST SOIL OR SAWDUST IF NOT PROMPTLY PLANTED UPON ARRIVAL TO THE PROJECT SITE.
8. DURING PLANTING, SEEDLINGS SHALL BE KEPT IN A MOIST CANVAS BAG OR SIMILAR CONTAINER TO PREVENT ROOT SYSTEMS FROM DYING.
9. PLANTING BAR SHALL HAVE A BLADE WITH A TRIANGULAR CROSS SECTION AND SHALL BE 12 INCHES LONG, 4 INCHES WIDE AND 1 INCH THICK AT CENTER.
10. ALL SEEDLINGS SHALL BE PRUNED IF NECESSARY, SO THAT NO ROOTS EXTEND MORE THAN 10 INCHES BELOW THE ROOT COLLAR.

PLANTING BAG



PLANTING BAR

BARE ROOT PLANTING DETAIL

NOT TO SCALE

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PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 36916 ENGINEER CHRISTOPHER A. TOMSIC

PRELIMINARY - NOT FOR CONSTRUCTION

ENGINEERING SERVICES BY
WLS ENGINEERING, PLLC
6 DULA SPRINGS RD.
WEAVERVILLE, NC 28787
FIRM LICENSE NO. P-1480

REVISIONS

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PROJECT NAME

HORNPIPE BRANCH TRIBUTARIES MITIGATION PROJECT

LENOIR COUNTY, NC

DRAWING INFORMATION

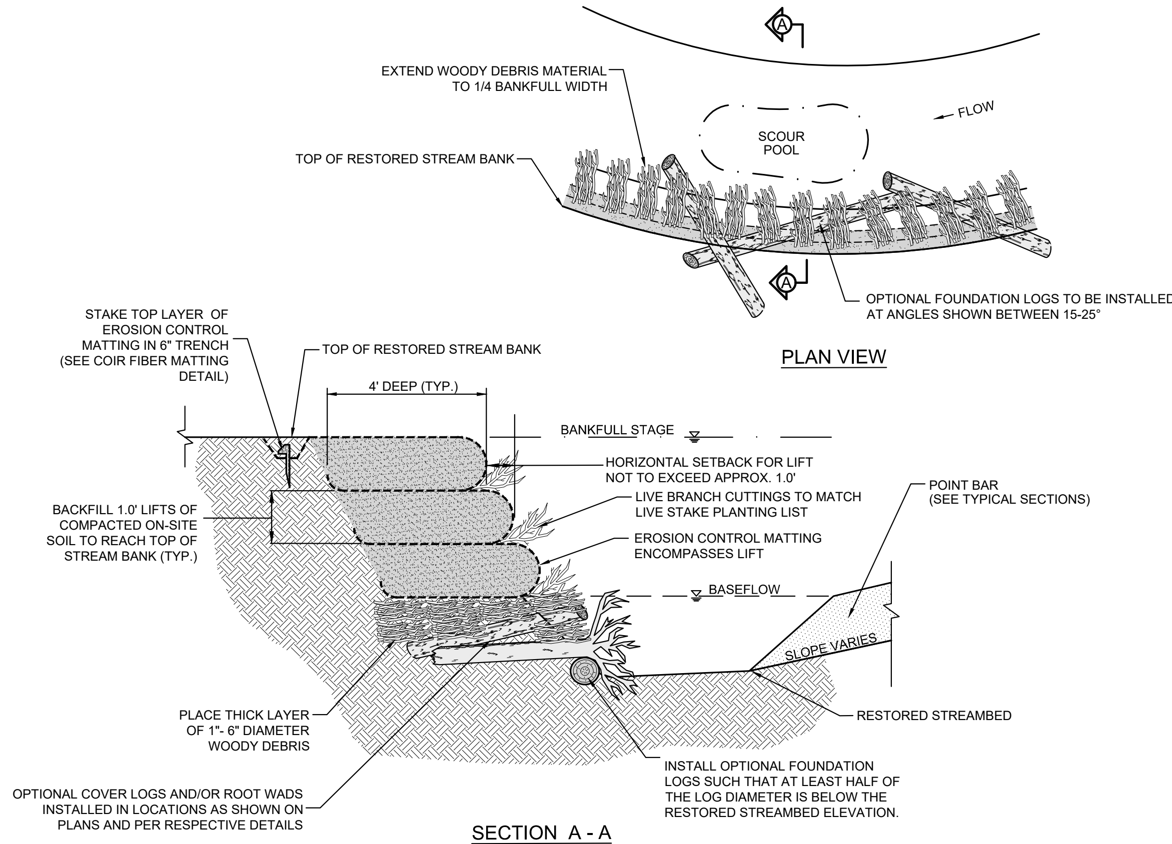
PROJECT NO.	18-006
FILENAME	04-07_HORNPIPE_DETAIL_SHEETS.DWG
DESIGNED BY	KMV
DRAWN BY	APL/JNC
DATE	8-24-20
HORIZ. SCALE	N.T.S.
VERT. SCALE	N/A

SHEET NAME

DETAILS

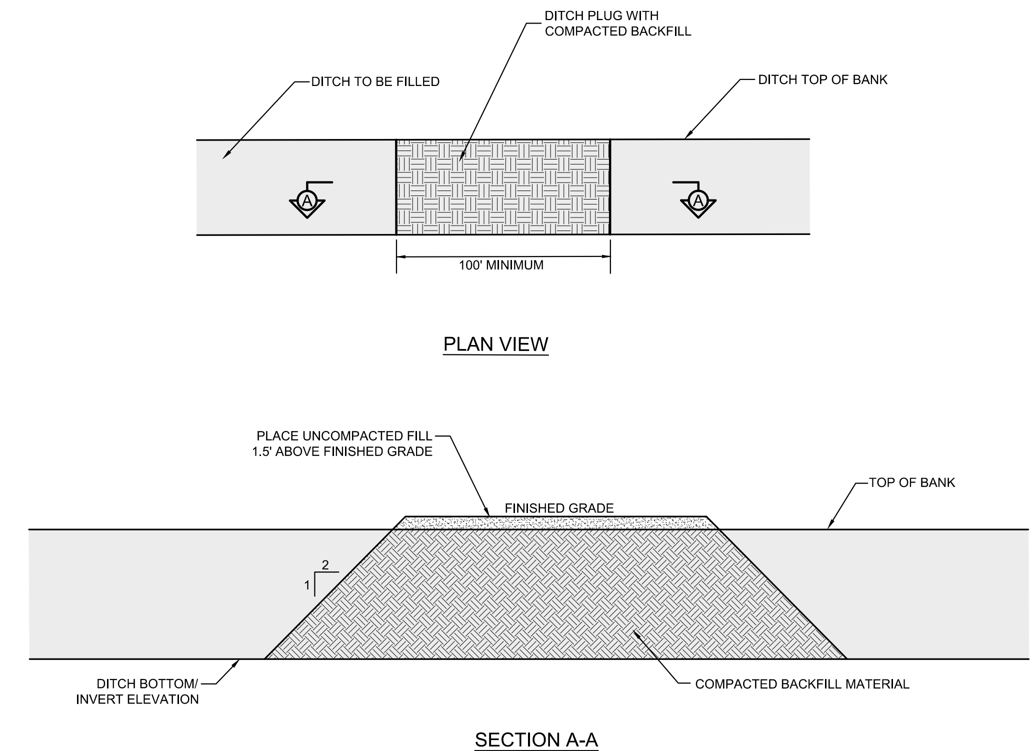
SHEET NUMBER

5



GEOLIFT W/ TOE WOOD

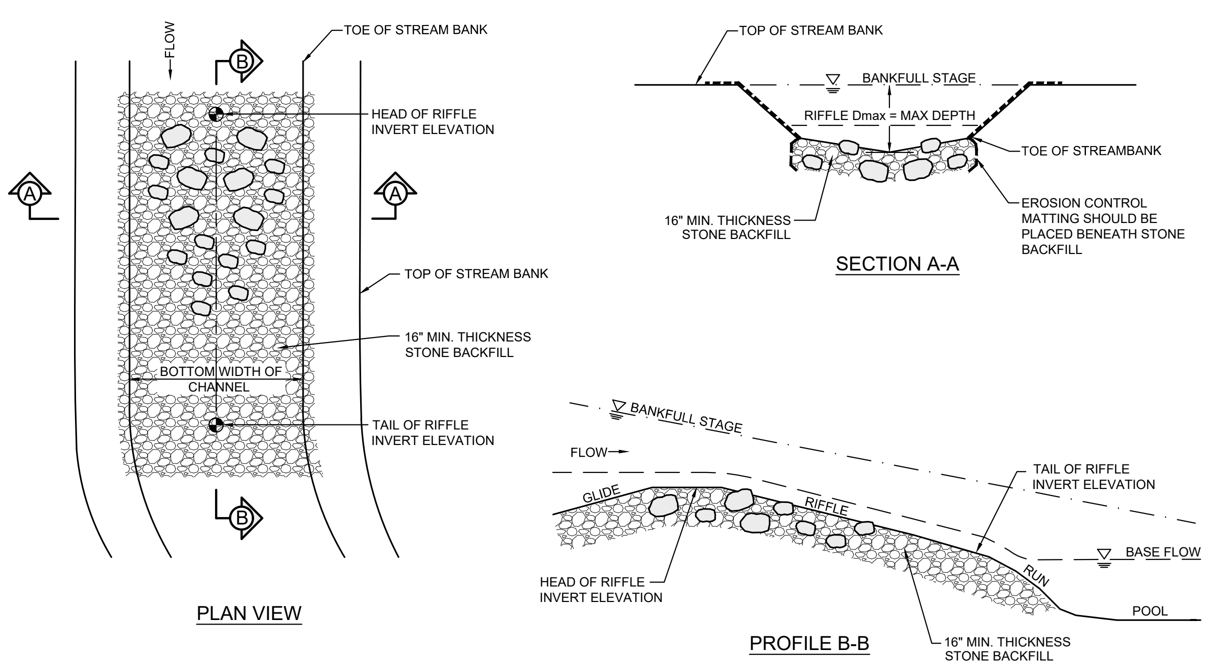
NOT TO SCALE



NOTES:
1. COMPACT DITCH PLUG MATERIAL FOR BACKFILL USING HEAVY EQUIPMENT IN 10 INCH LIFTS.
2. CONSTRUCT DITCH PLUG WITH COMPACTED SOIL USING SUITABLE MATERIAL IN ACCORDANCE WITH THE TECHNICAL SPECIFICATIONS.
3. PLACE FILL MATERIAL IN LOCATIONS SHOWN ON PLANS OR AS DIRECTED BY ENGINEER TO ALLOW FOR SETTLING.

DITCH PLUG

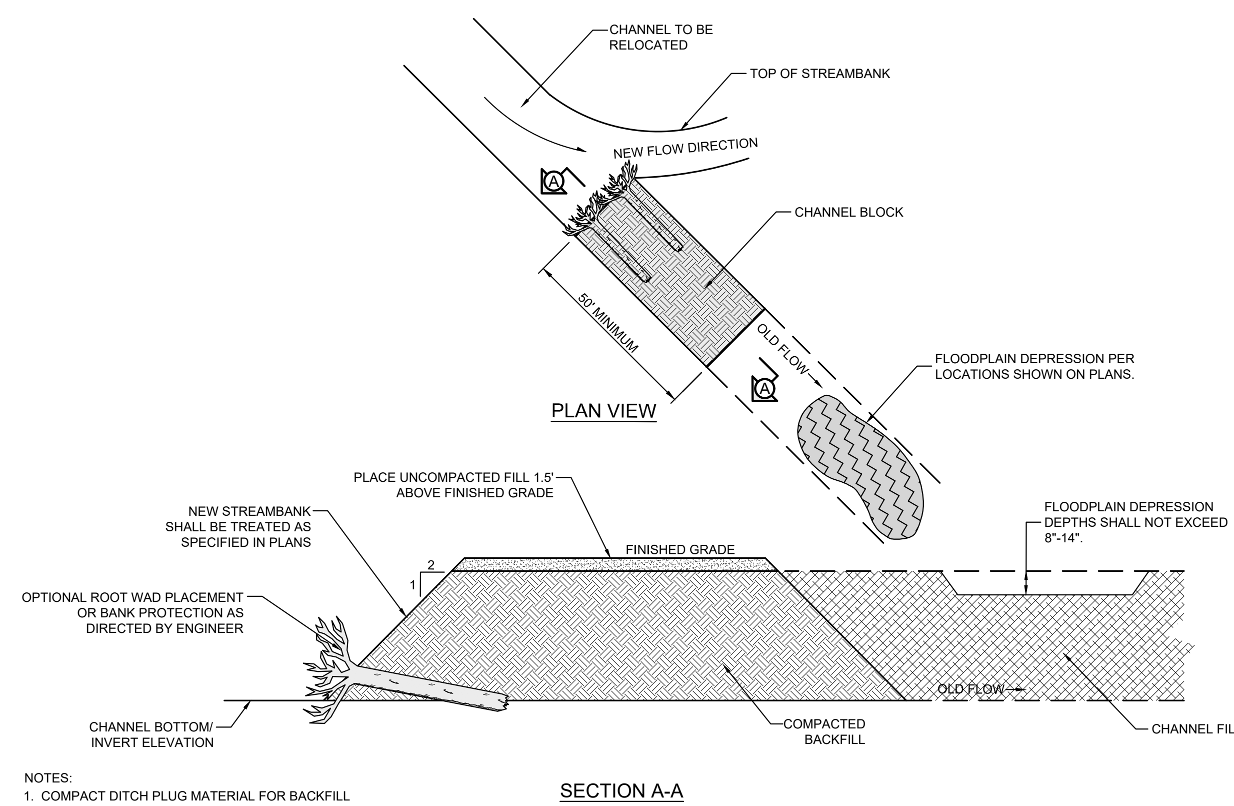
NOT TO SCALE



NOTES:
1. DIG A TRENCH BELOW THE RESTORED STREAMBED FOR THE STONE BACKFILL.
2. FILL TRENCH WITH CLASS "A" AND "B" STONE BACKFILL.

CONSTRUCTED STONE RIFFLE

NOT TO SCALE



NOTES:
1. COMPACT DITCH PLUG MATERIAL FOR BACKFILL USING HEAVY EQUIPMENT IN 10 INCH LIFTS.
2. CONSTRUCT DITCH PLUG WITH COMPACTED SOIL USING SUITABLE MATERIAL IN ACCORDANCE WITH THE TECHNICAL SPECIFICATIONS.
3. PLACE FILL MATERIAL IN LOCATIONS SHOWN ON PLANS OR AS DIRECTED BY ENGINEER TO ALLOW FOR SETTLING.

CHANNEL BLOCK

NOT TO SCALE

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PROJECT ENGINEER

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PRELIMINARY PLANS NOT FOR CONSTRUCTION

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REVISIONS

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A	DRAFT MIT PLAN	2-21-20
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C	FINAL MIT PLAN	8-24-20

PROJECT NAME

HORNPIPE BRANCH TRIBUTARIES MITIGATION PROJECT

LENOIR COUNTY, NC

DRAWING INFORMATION

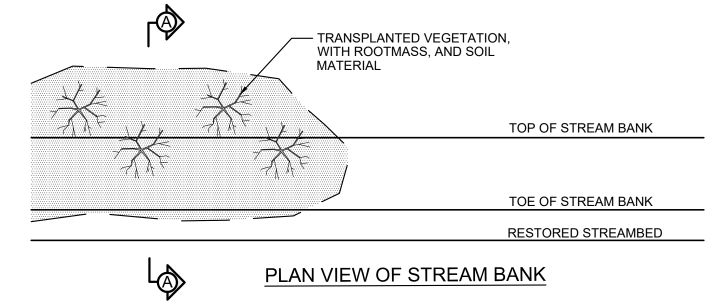
PROJECT NO.	18-006
FILENAME	04-07_HORNPIPE_DETAIL_SHEETS.DWG
DESIGNED BY	KMV
DRAWN BY	APL/JNC
DATE	8-24-20
HORIZ. SCALE	N.T.S.
VERT. SCALE	N/A

SHEET NAME

DETAILS

SHEET NUMBER

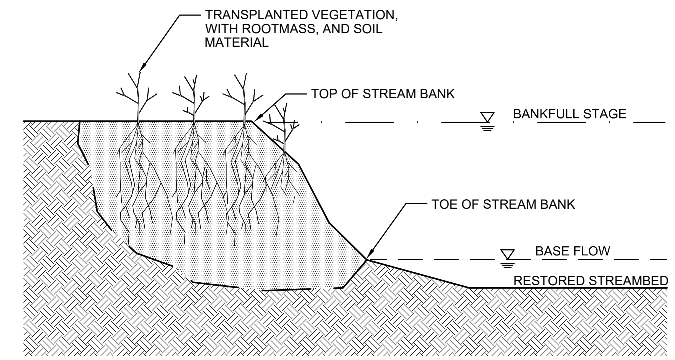
6



PLAN VIEW OF STREAM BANK

NOTES:

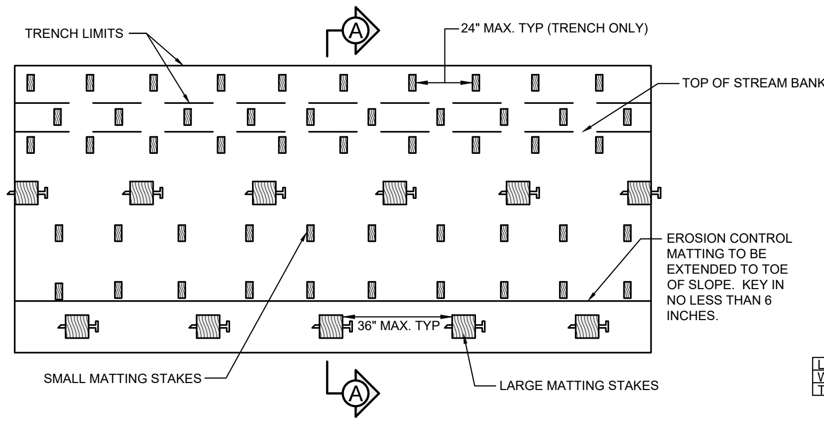
1. EXCAVATE A HOLE IN THE RESTORED STREAM BANK THAT WILL ACCOMMODATE THE SIZE OF TRANSPLANT TO BE PLANTED. BEGIN EXCAVATION AT TOE OF THE STREAM BANK.
2. EXCAVATE THE ENTIRE TRANSPLANT ROOT MASS AND AS MUCH ADDITIONAL SOIL MATERIAL AS POSSIBLE. IF ENTIRE ROOT MASS CAN NOT BE EXCAVATED AT ONCE, THE TRANSPLANT IS TOO LARGE AND ANOTHER SHOULD BE SELECTED.
3. PLANT TRANSPLANT IN THE RESTORED STREAM BANK SO THAT VEGETATION IS ORIENTATED VERTICALLY.
4. FILL IN ANY HOLES OR VOIDS AROUND THE TRANSPLANT AND COMPACT.
5. ANY LOOSE SOIL LEFT IN THE STREAM SHOULD BE REMOVED.
6. WHEN POSSIBLE, PLACE MULTIPLE TRANSPLANTS CLOSE TOGETHER SUCH THAT THEIR ROOT MASSES CONTACT.



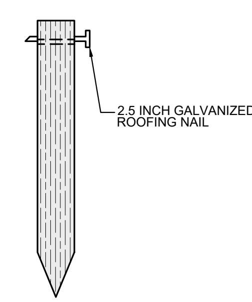
SECTION A-A

VEGETATION TRANSPLANTS

NOT TO SCALE

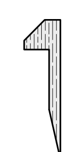


PLAN VIEW OF STREAM BANK



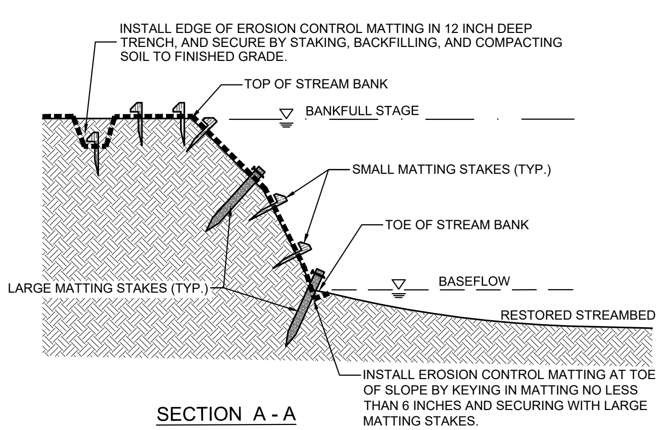
TYPICAL LARGE MATTING STAKE

LENGTH	24.00 IN (60.96 CM) (TAPERED TO POINT)
WIDTH	1.5 IN (3.81 CM)
THICKNESS	1.5 IN (3.81 CM)



TYPICAL SMALL MATTING STAKE

LEG LENGTH	11.00 IN (27.94 CM)
HEAD WIDTH	1.25 IN (3.18 CM)
HEAD THICKNESS	0.40 IN (1.02 CM)
LEG WIDTH	0.60 IN (1.52 CM) (TAPERED TO POINT)
LEG THICKNESS	0.40 IN (1.02 CM)
TOTAL LENGTH	12.00 IN (30.48 CM)



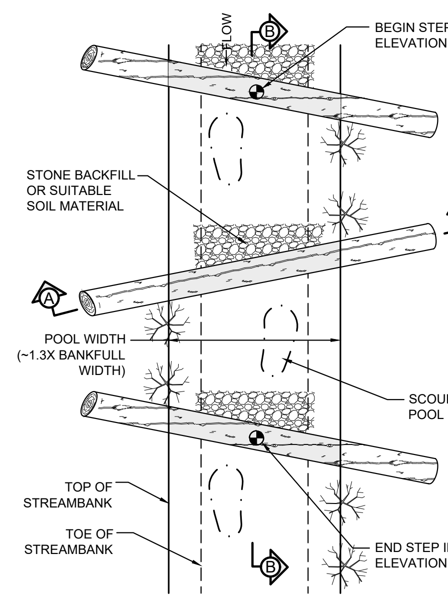
SECTION A - A

NOTES:

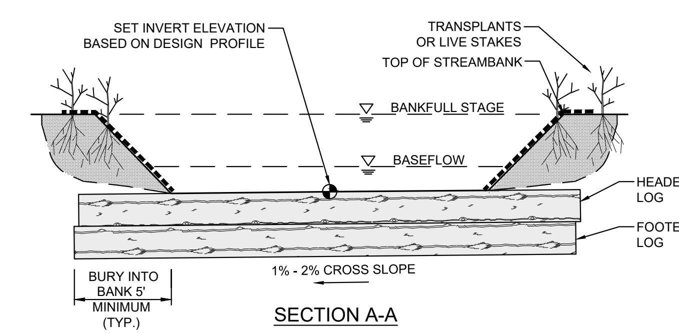
1. RESTORED STREAM BANKS MUST BE SEEDED AND MULCHED PRIOR TO PLACEMENT OF EROSION CONTROL MATTING.
2. SEE TECHNICAL SPECIFICATIONS FOR MATTING STAKE SPACING REQUIREMENTS.
3. PLACE LARGE STAKES ALONG ALL MATTING SEAMS, IN THE CENTER OF STREAM BANK, AND TOE OF SLOPE.

EROSION CONTROL MATTING

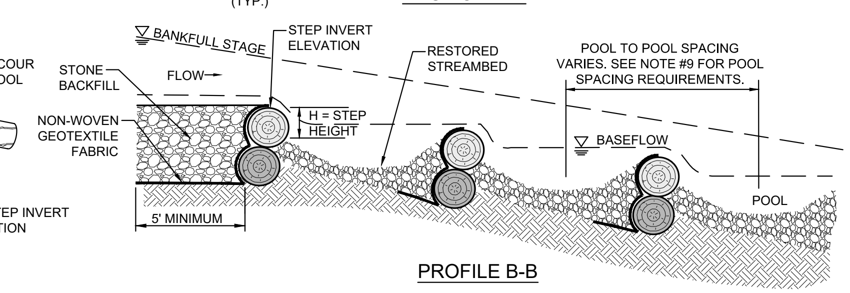
NOT TO SCALE



PLAN VIEW



SECTION A-A



PROFILE B-B

NOTES:

1. LOGS SHOULD BE AT LEAST 12 INCHES IN DIAMETER, RELATIVELY STRAIGHT HARDWOOD AND RECENTLY HARVESTED.
2. LOGS >24 INCHES IN DIAMETER MAY BE USED ALONE WITHOUT AN ADDITIONAL LOG FILTER FABRIC SHOULD STILL BE USED TO SEAL AROUND LOG. LOGS SHOULD EXTEND INTO THE BANKS 5' ON EACH SIDE.
3. SOIL SHALL BE WELL COMPACTED AROUND BURIED PORTION OF FOOTER LOGS WITH BUCKET OF TRACK HOE.
4. INSTALL NON-WOVEN GEOTEXTILE FABRIC UNDERNEATH LOGS.
5. UNDERCUT POOL BED ELEVATION 8 INCHES TO ALLOW FOR LAYER OF STONE. INSTALL STONE BACKFILL OR SUITABLE ALLUVIUM ALONG SIDE SLOPES.
6. INSTALL EROSION CONTROL MATTING ALONG COMPLETED BANKS SUCH THAT THE EROSION CONTROL MATTING AT THE TOE OF THE BANK EXTENDS DOWN TO THE UNDERCUT ELEVATION.
7. INSTALL STONE BACKFILL OR SUITABLE SOIL MATERIAL ALONG SIDE SLOPES.
8. FINAL CHANNEL BED SHAPE SHOULD BE ROUNDED, COMPACTED, AND CONCAVE, WITH THE ELEVATION OF THE BED APPROXIMATELY 0.5 FT DEEPER IN THE CENTER THAN AT THE EDGES.
9. AVERAGE POOL TO POOL SPACING SHALL BE SHOWN ON THE PROFILE OR SPECIFIED BY ENGINEER BASED ON EXISTING CONDITIONS SUCH AS SLOPE AND SUITABLE FILL MATERIAL. RIFFLE STEP POOLS OR CASCADE POOLS MAY BE SUBSTITUTED IN AREAS WHERE EXISTING SLOPES EXCEED 10% AS DETERMINED BY THE ENGINEER.
10. INTERIOR LOGS SHOULD BE AT A SLIGHT ANGLE (~70 DEGREES) FROM THE STREAMBANK AND CROSS SLOPES SHOULD BE 1-2%.
11. PLACE FOOTER LOGS FIRST AND THEN HEADER (TOP) LOG. SET HEADER LOG AT A MAXIMUM OF 3 INCHES ABOVE THE INVERT ELEVATION.
12. AVERAGE STEP HEIGHTS/DROPS SHALL NOT EXCEED 0.5 UNLESS SHOWN OTHERWISE.
13. CUT A NOTCH IN THE HEADER LOG APPROXIMATELY 30% OF THE CHANNEL BOTTOM WIDTH AND EXTENDING DOWN TO THE INVERT ELEVATION. NOTCH SHALL BE USED TO CENTER FLOW AND NOT EXCEED 3 INCHES IN DEPTH.
14. THE NUMBER OF STEPS MAY VARY BETWEEN BEGINNING AND END STATIONING. SEE LONGITUDINAL PROFILE FOR STATION AND ELEVATION.
15. USE GEOTEXTILE FABRIC FOR DRAINAGE TO SEAL GAPS BETWEEN LOGS.
16. PLACE VEGETATION TRANSPLANTS FROM TOE OF STREAMBANK TO TOP OF STREAMBANK.
17. SEE TYPICAL SECTION FOR CHANNEL DIMENSIONS.

LOG STEP POOL

NOT TO SCALE

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Raleigh, NC 27615
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PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 36916 ENGINEER CHRISTOPHER A. TOMSIC

PRELIMINARY PLANS NOT FOR CONSTRUCTION

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6 DULA SPRINGS RD.
WEAVERVILLE, NC 28787
FIRM LICENSE NO. P-1480

REVISIONS

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A	DRAFT MIT PLAN	2-21-20
B	FINAL DRAFT MIT PLAN	4-8-20
C	FINAL MIT PLAN	8-24-20

PROJECT NAME

HORNPIPE BRANCH TRIBUTARIES MITIGATION PROJECT

LENOIR COUNTY, NC

DRAWING INFORMATION

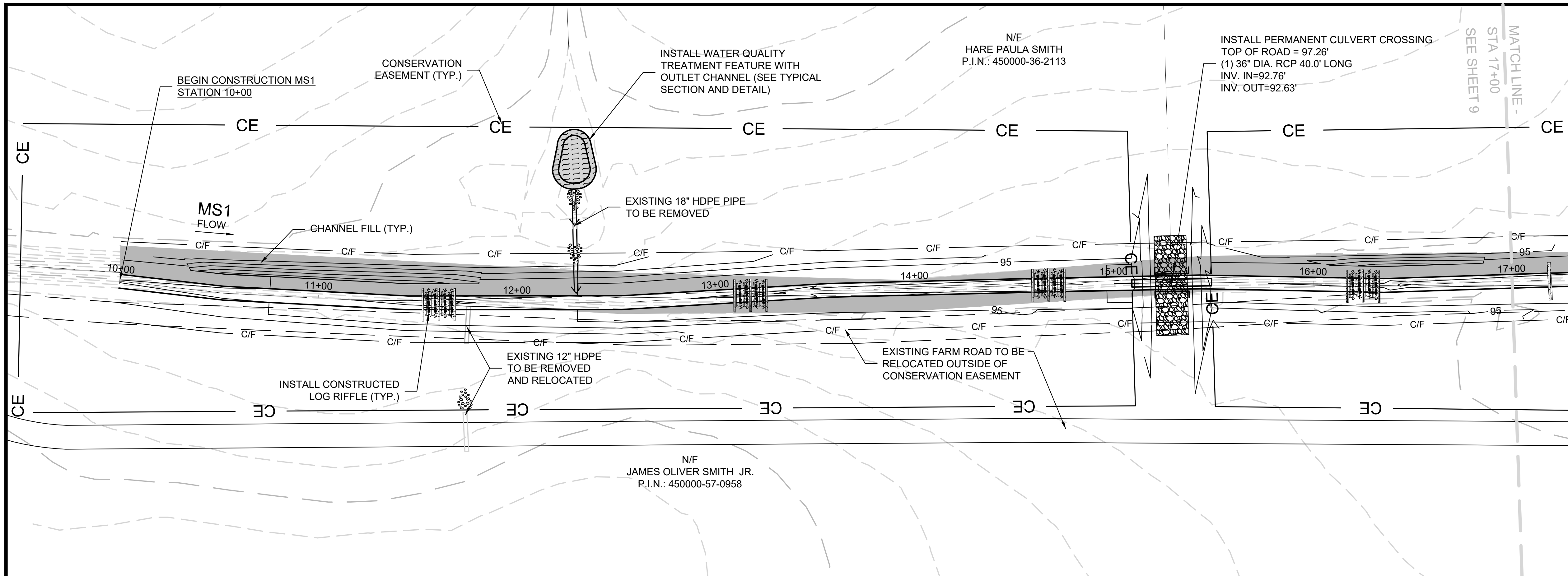
PROJECT NO.	18-006
FILENAME	04-07_HORNPIPE_DETAIL_SHEETS.DWG
DESIGNED BY	KMV
DRAWN BY	APL/JNC
DATE	8-24-20
HORIZ. SCALE	N.T.S.
VERT. SCALE	N/A

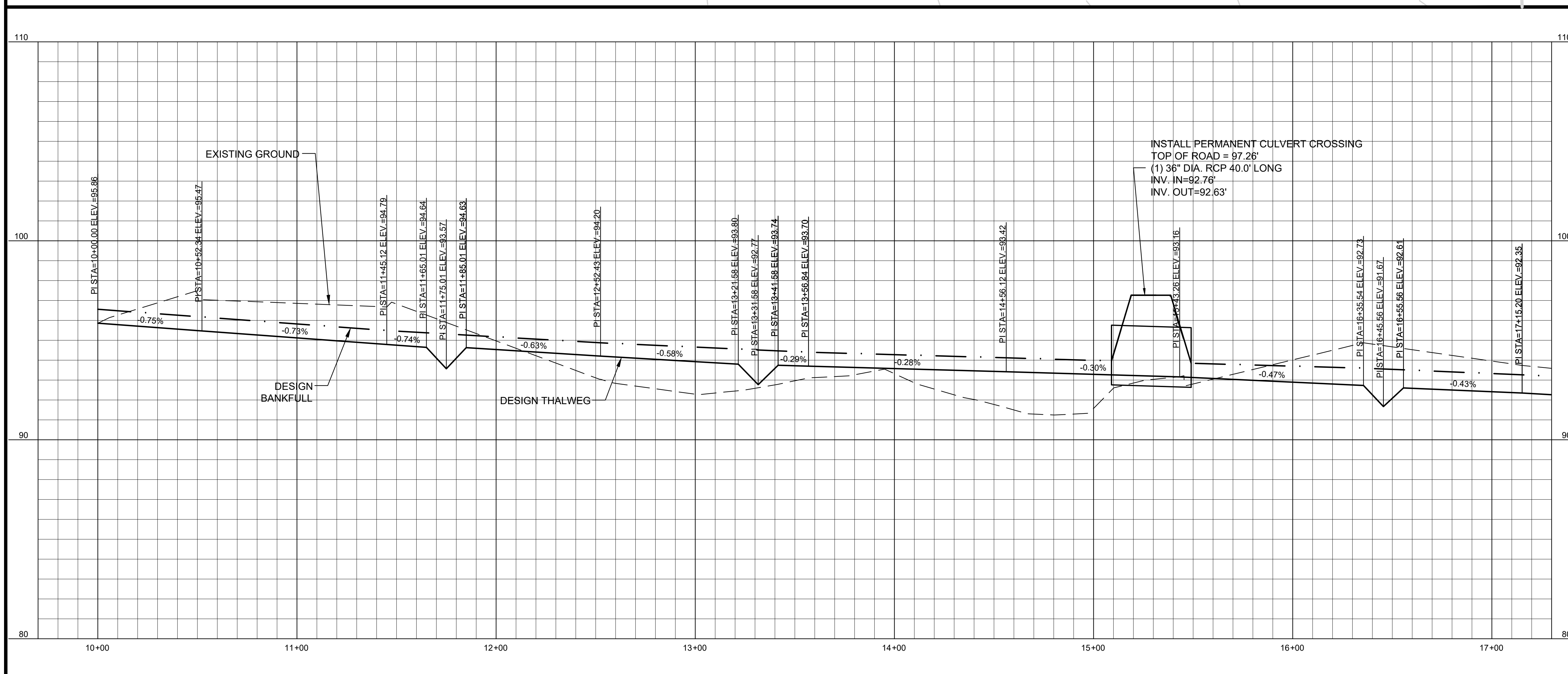
SHEET NAME

DETAILS

SHEET NUMBER

7





WATER & LAND SOLUTIONS

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PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 36916 CHRISTOPHER A. TOMSIC

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PROJECT NAME

HORNPIPE BRANCH TRIBUTARIES MITIGATION PROJECT

LENOIR COUNTY, NC

DRAWING INFORMATION

PROJECT NO.	18-006
FILENAME	08-16_HORNPIPE_PLAN AND PROFILES.DWG
DESIGNED BY	KMV
DRAWN BY	APL/JNC
DATE	8-24-20
HORIZ. SCALE	1" = 60'
VERT. SCALE	1" = 6'

NORTH

30 15 0 30 60

GRAPHIC SCALE

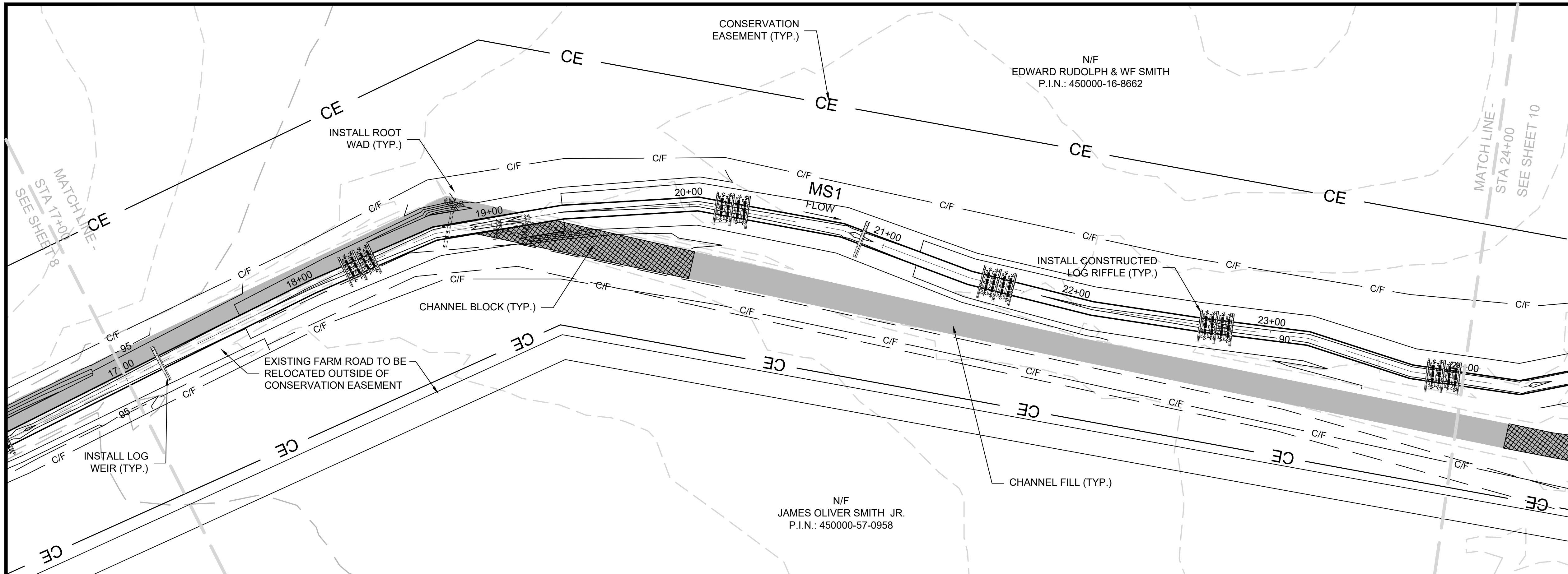
SHEET NAME

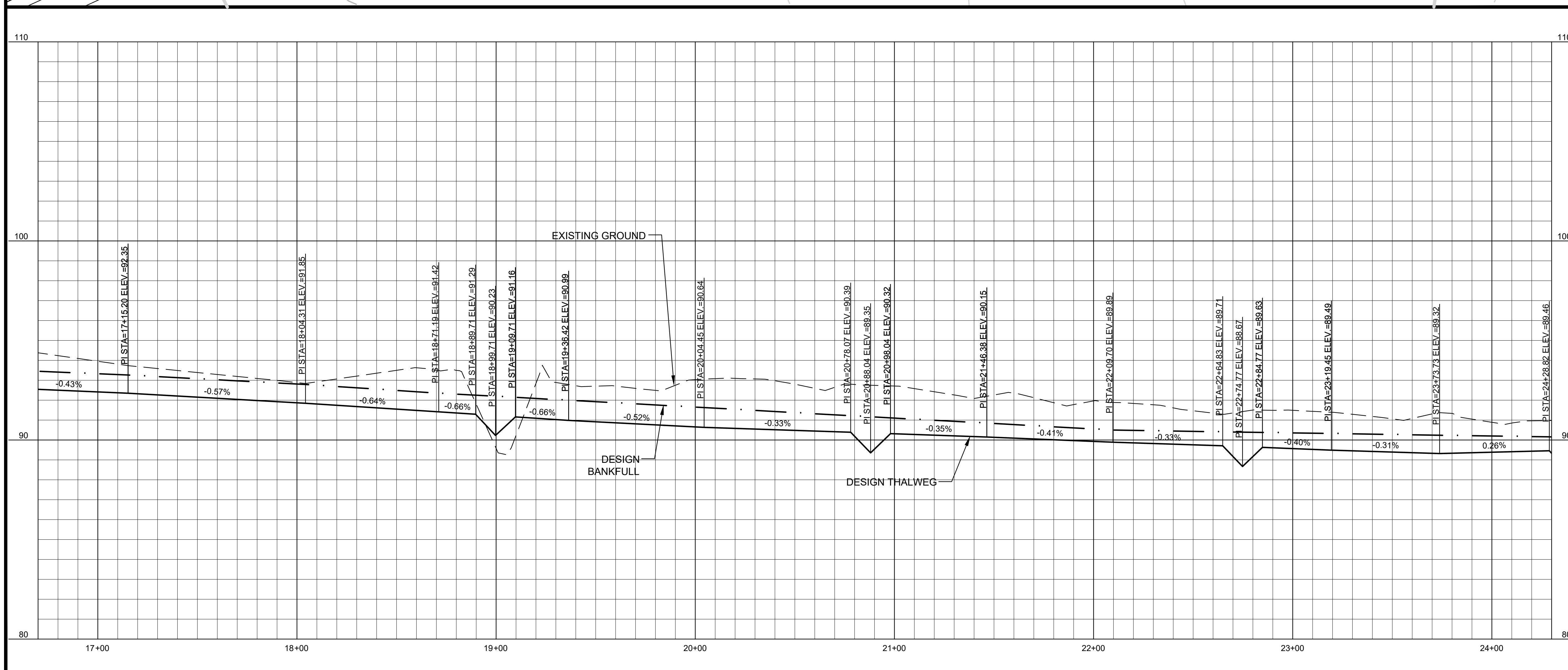
MS1

PLAN AND PROFILE

SHEET NUMBER

8





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PROJECT ENGINEER

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HORNPIPE BRANCH TRIBUTARIES MITIGATION PROJECT

LENOIR COUNTY, NC

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DRAWN BY	APL/JNC
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HORIZ. SCALE	1" = 60'
VERT. SCALE	1" = 6'

NORTH

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GRAPHIC SCALE

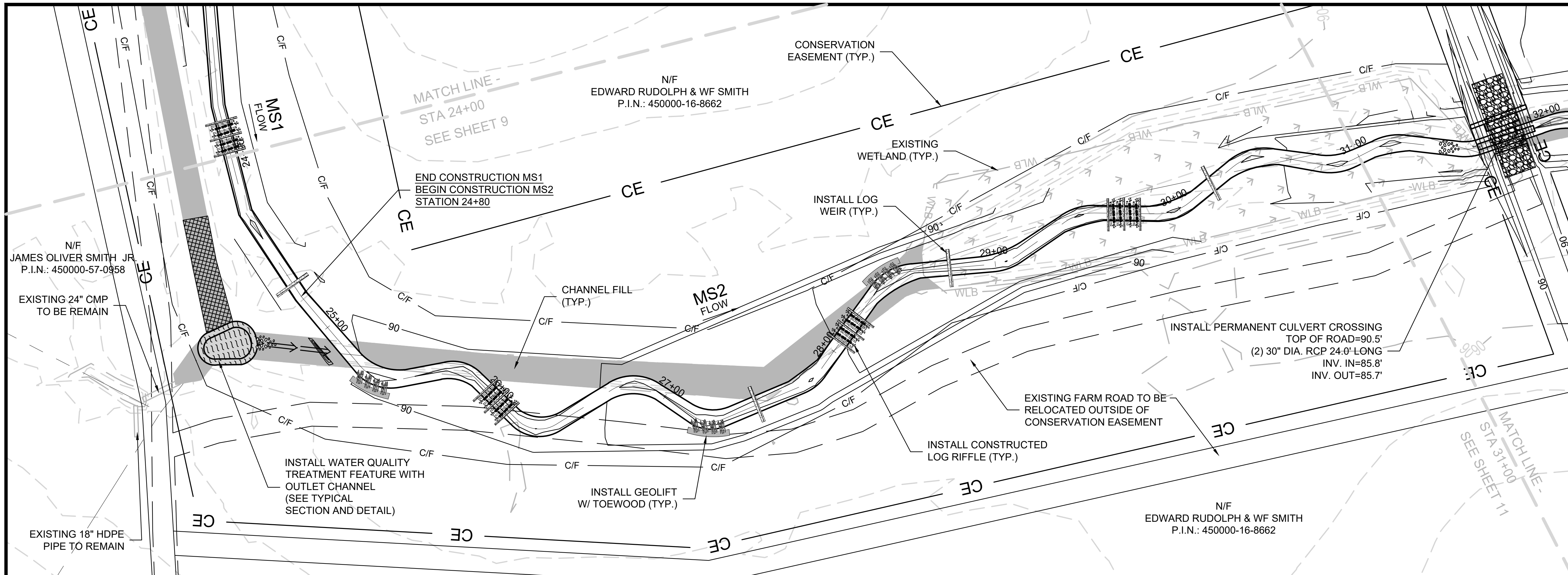
SHEET NAME

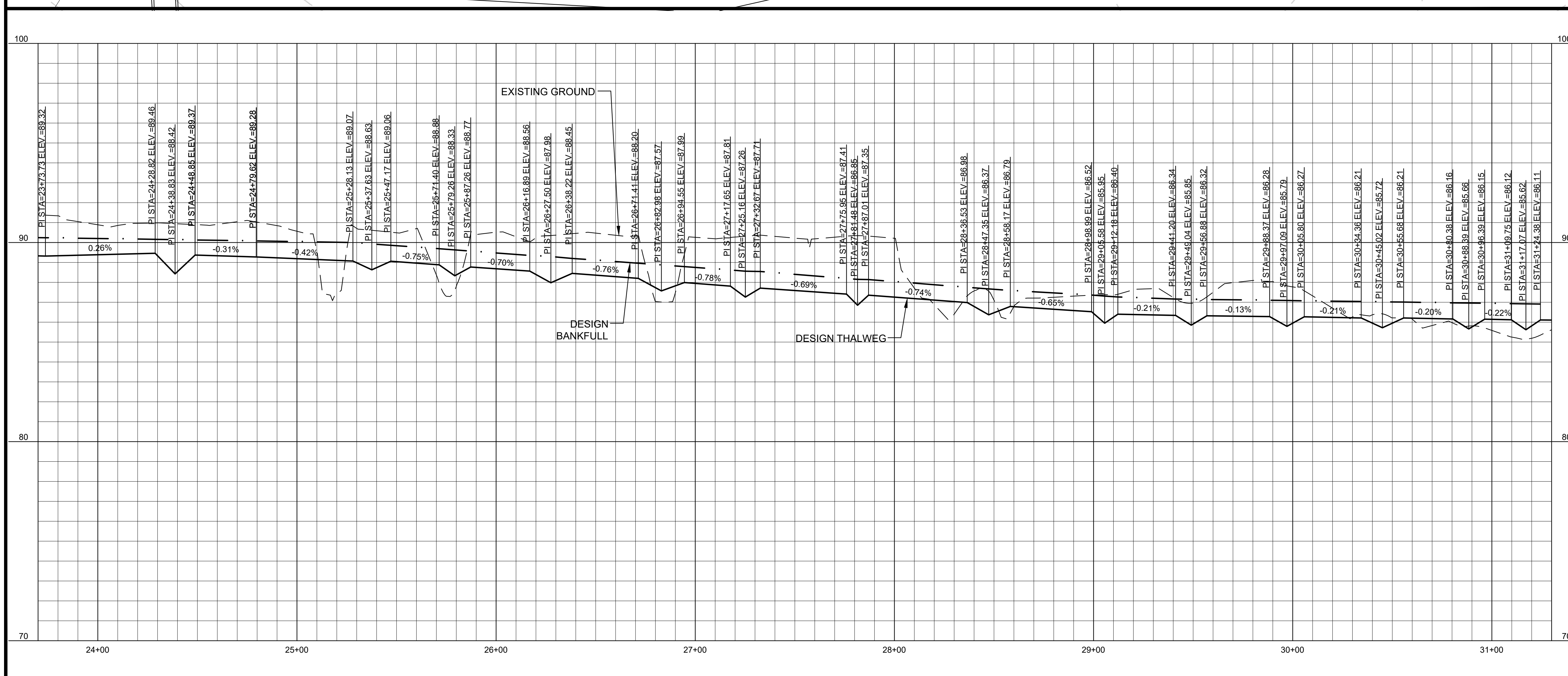
MS1

PLAN AND PROFILE

SHEET NUMBER

9





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NORTH

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GRAPHIC SCALE

SHEET NAME

MS1&MS2

PLAN AND PROFILE

SHEET NUMBER

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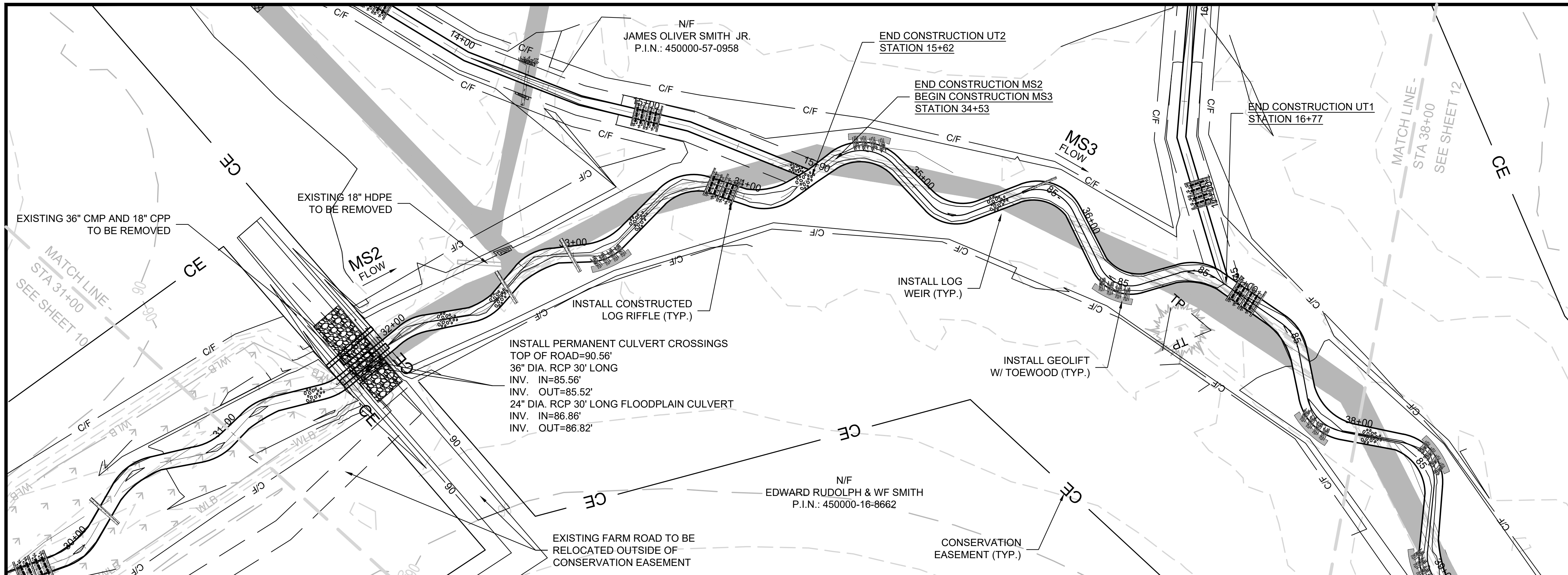

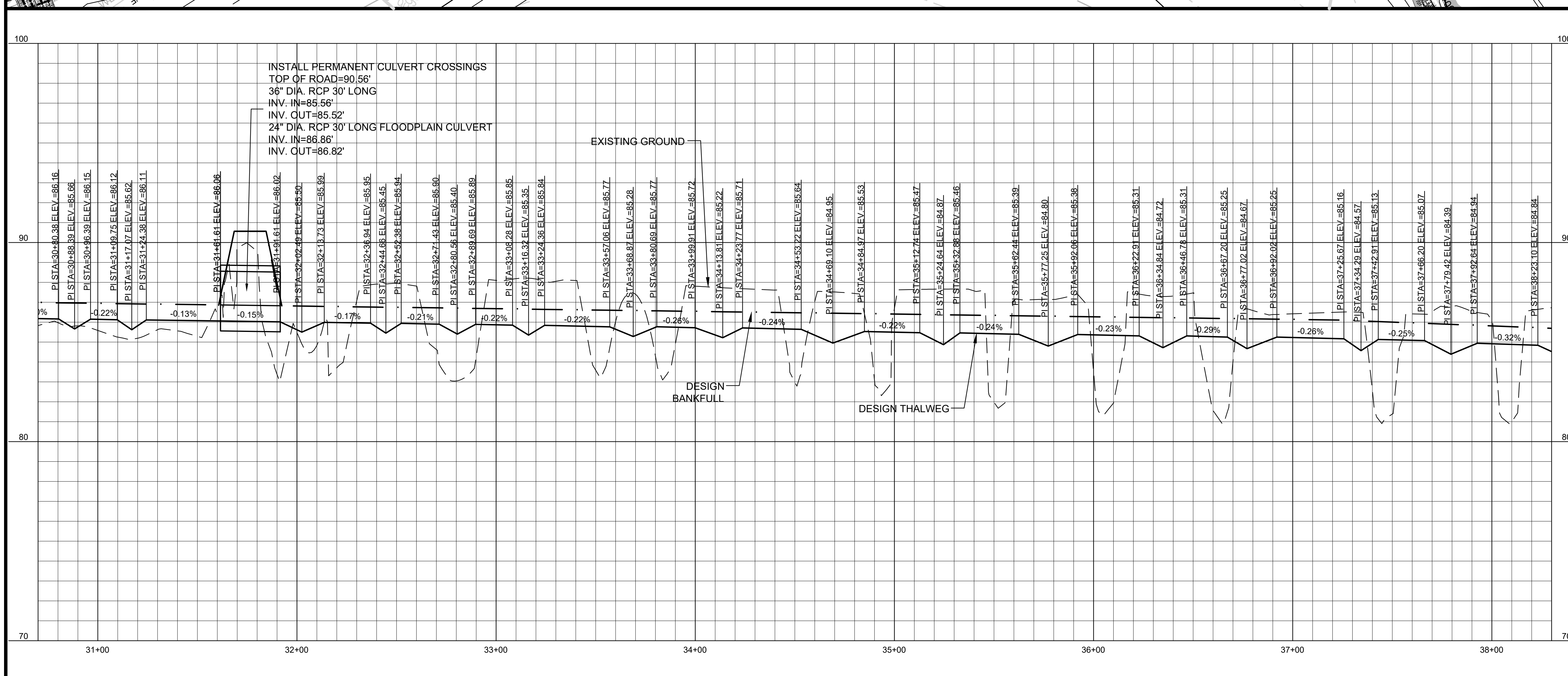

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NORTH

30 15 0 30 60

GRAPHIC SCALE

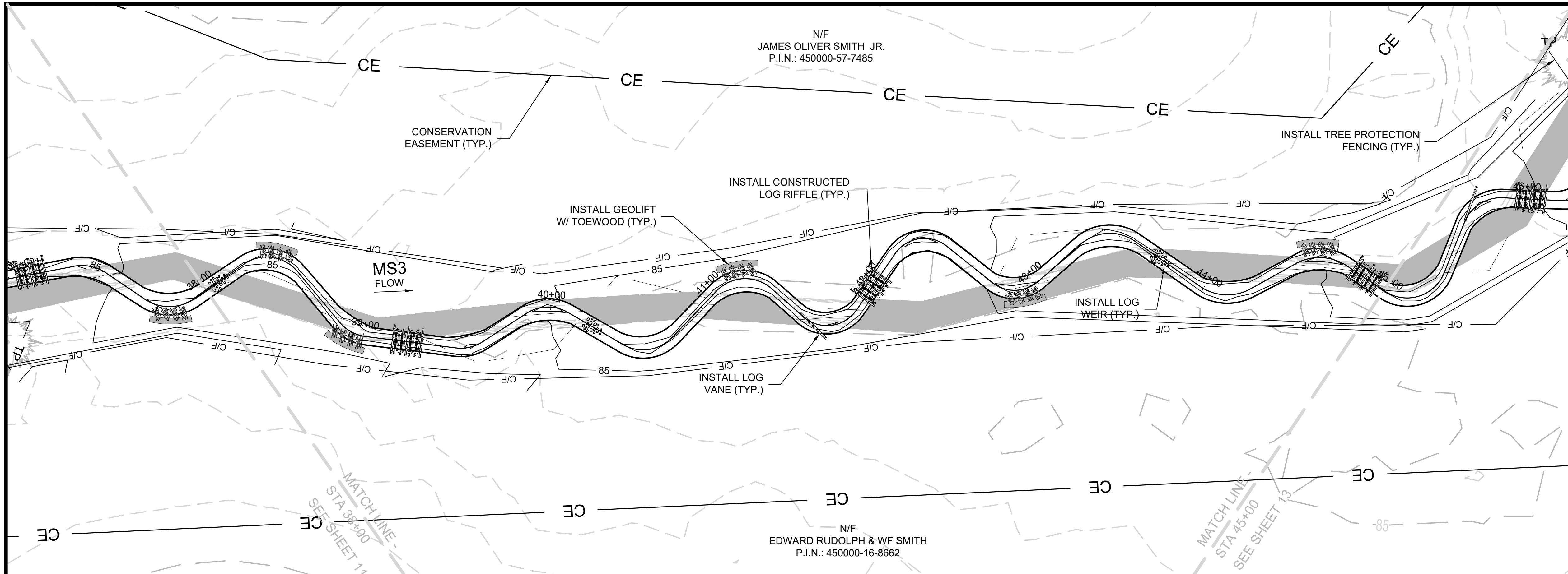
SHEET NAME

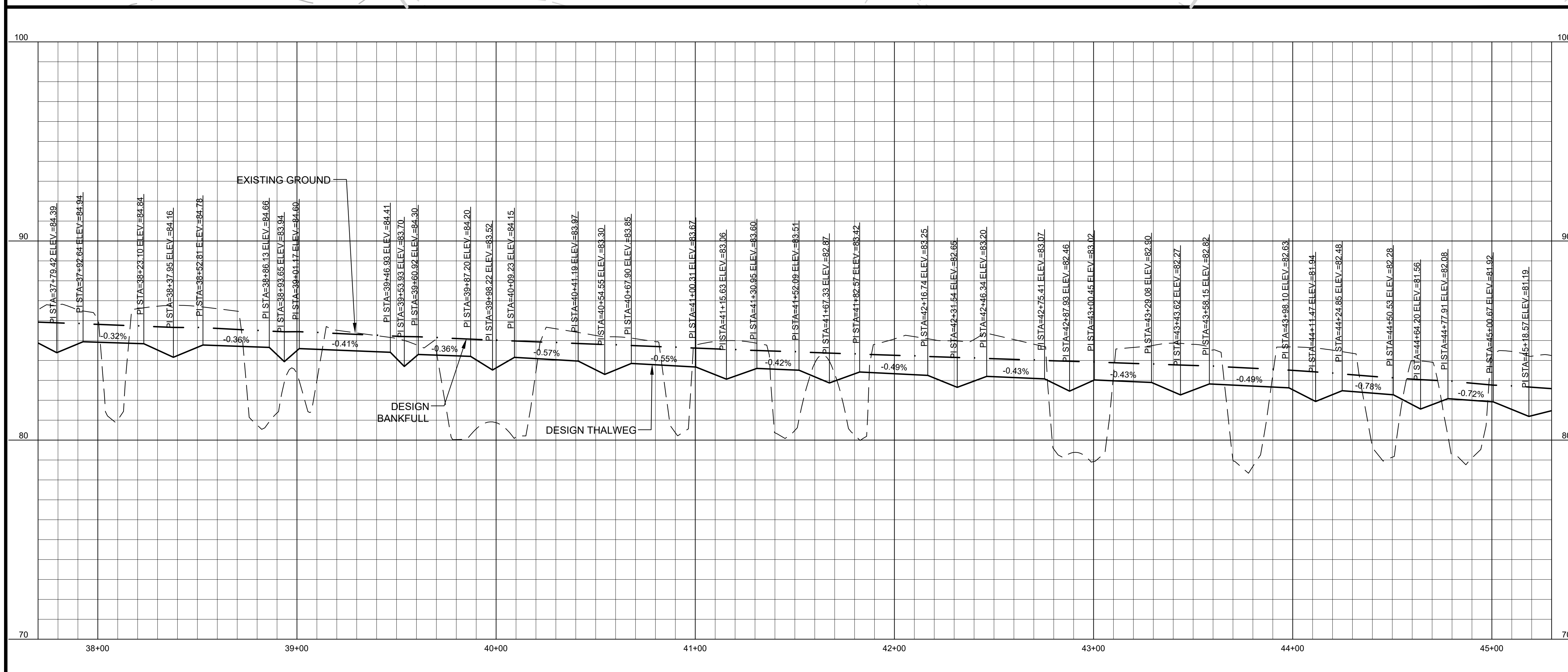
MS2&MS3

PLAN AND PROFILE

SHEET NUMBER

11





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NORTH

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GRAPHIC SCALE

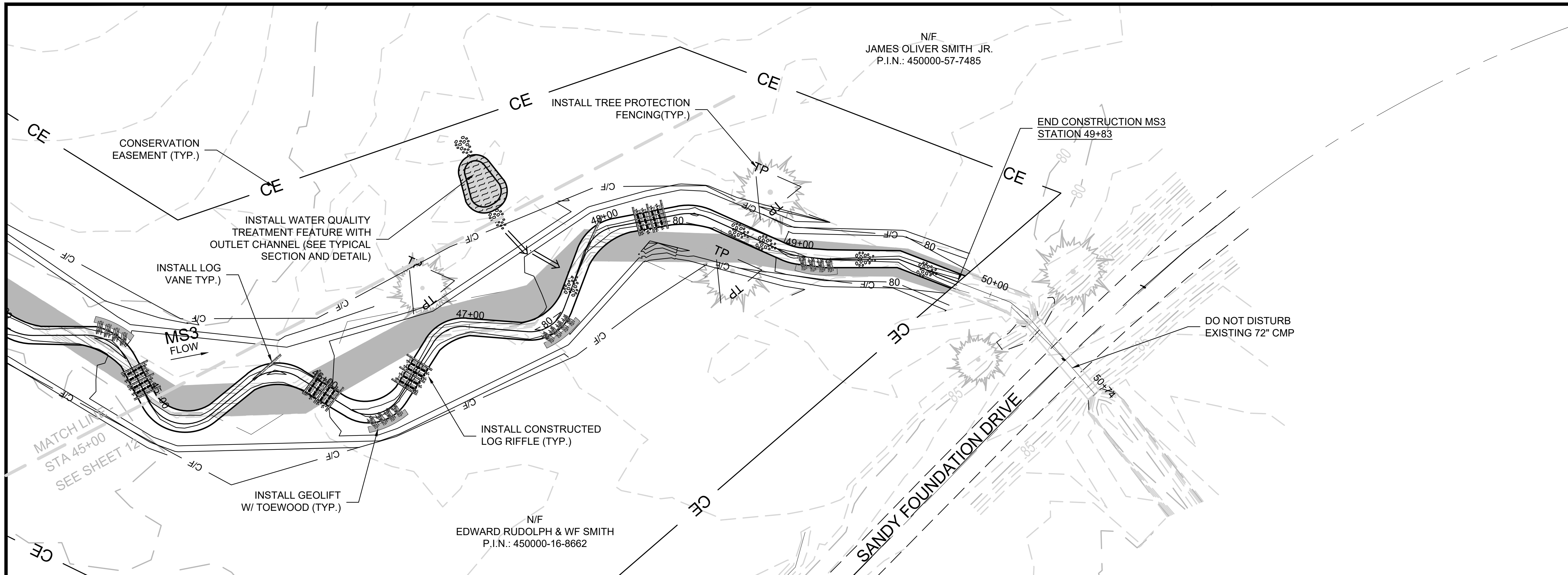
SHEET NAME

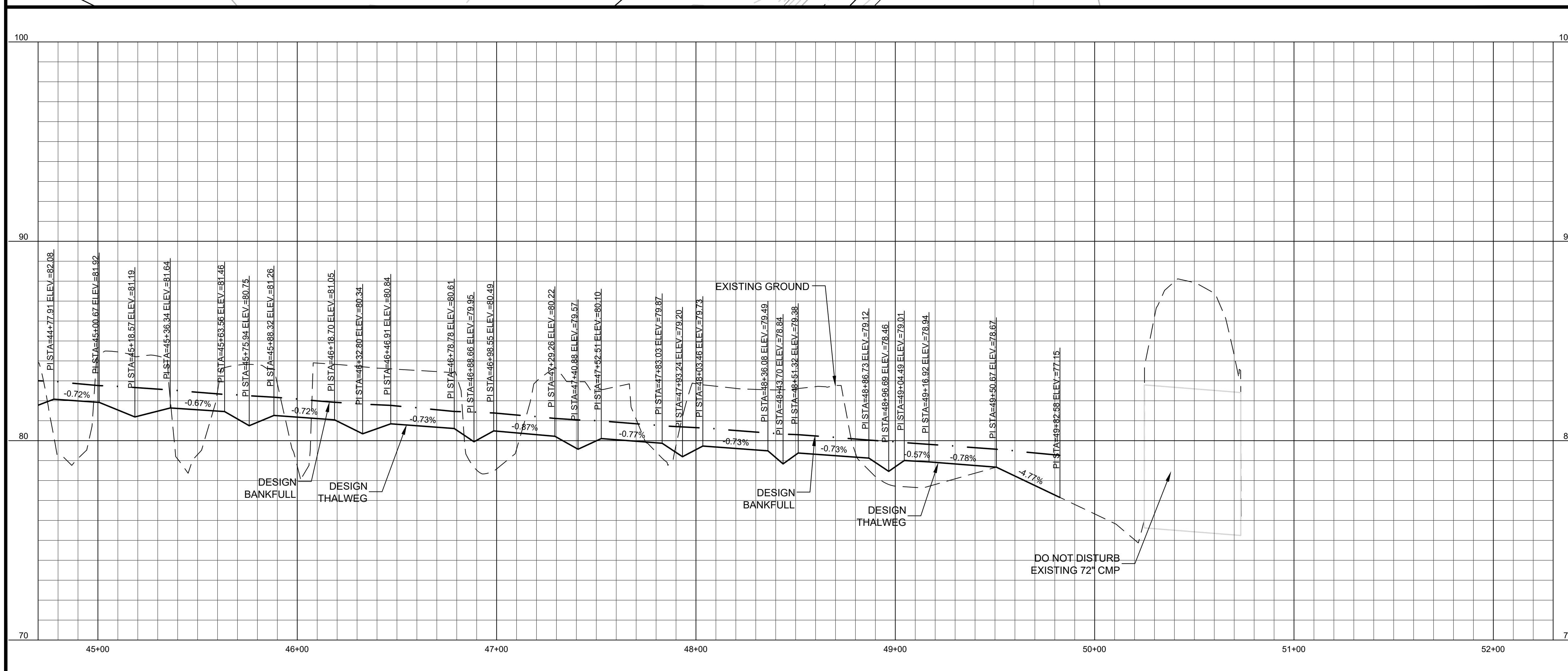
MS3

PLAN AND PROFILE

SHEET NUMBER

12





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NORTH

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GRAPHIC SCALE

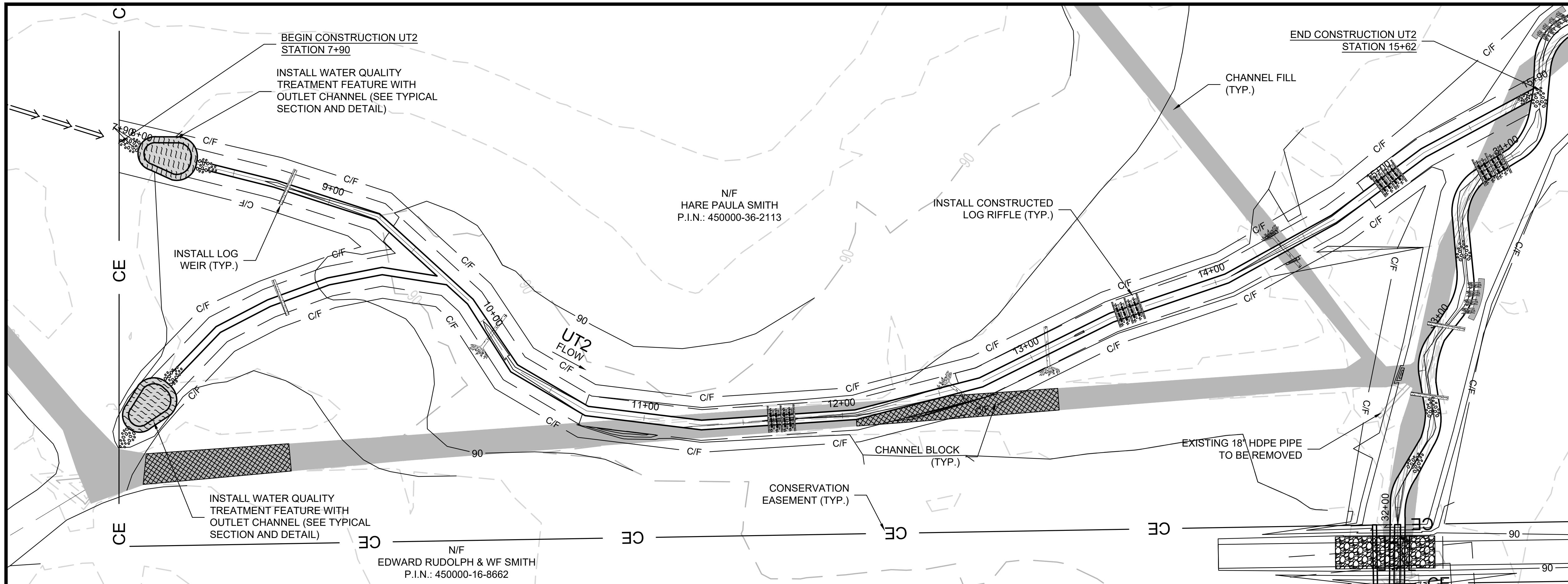
SHEET NAME

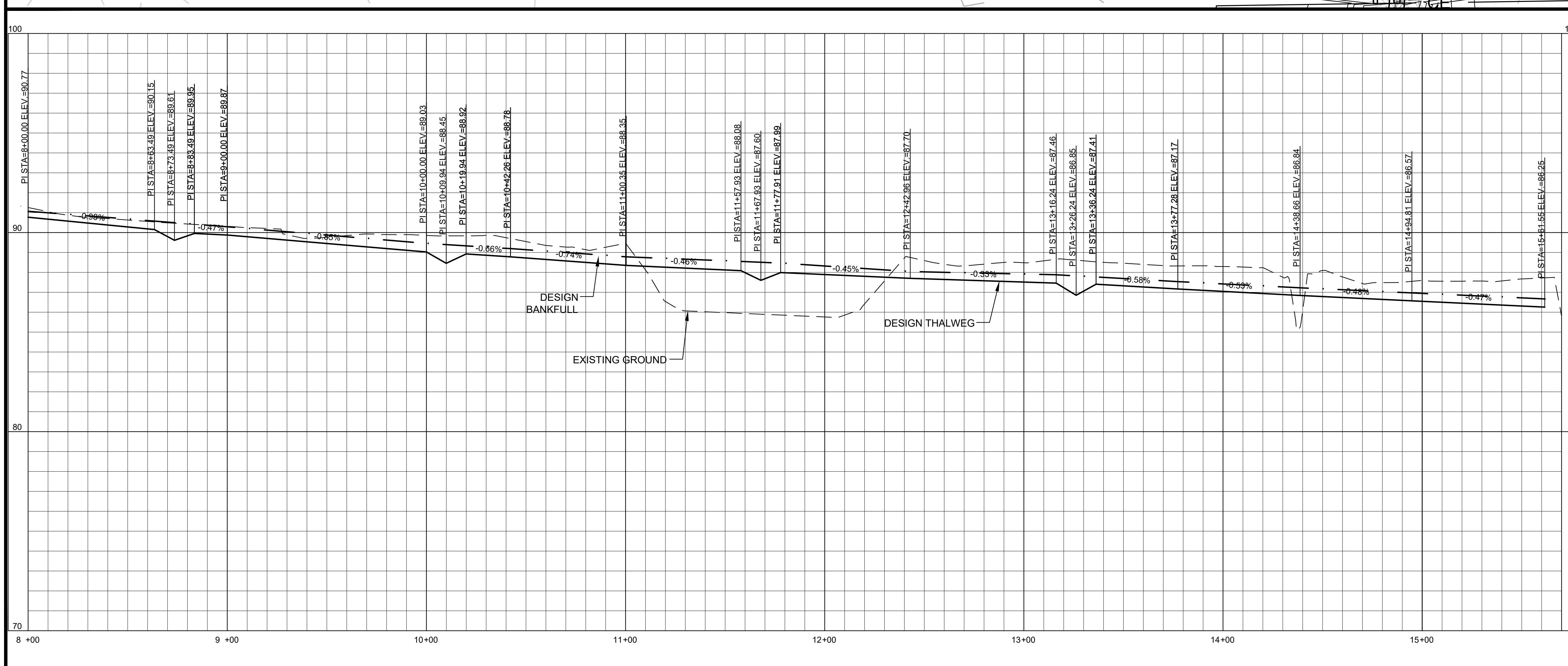
MS3

PLAN AND PROFILE

SHEET NUMBER

13





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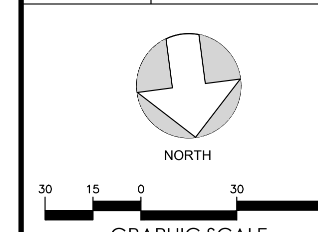


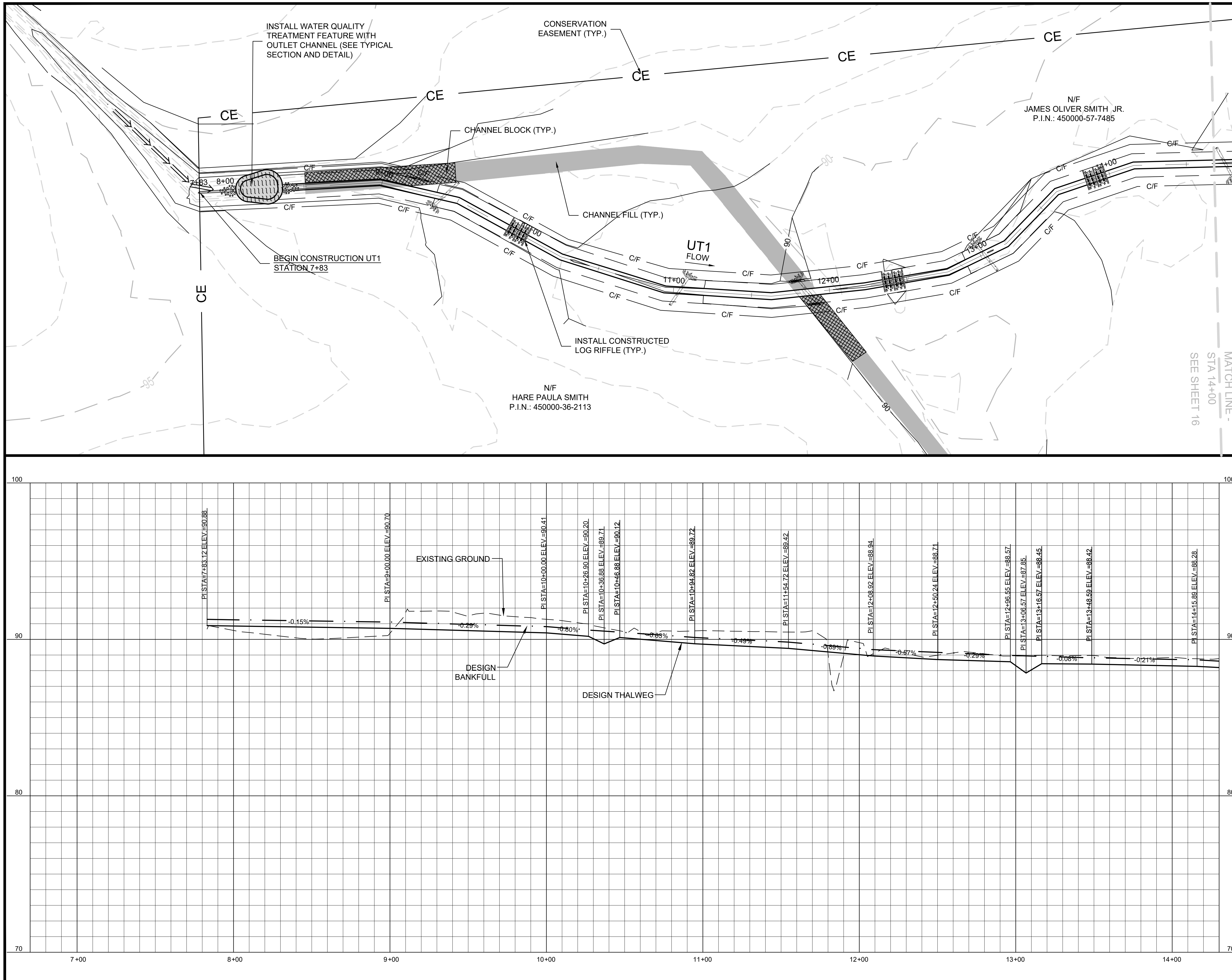
SHEET NAME

UT2

PLAN AND PROFILE

SHEET NUMBER

14



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NORTH

30 15 0 30 60

GRAPHIC SCALE

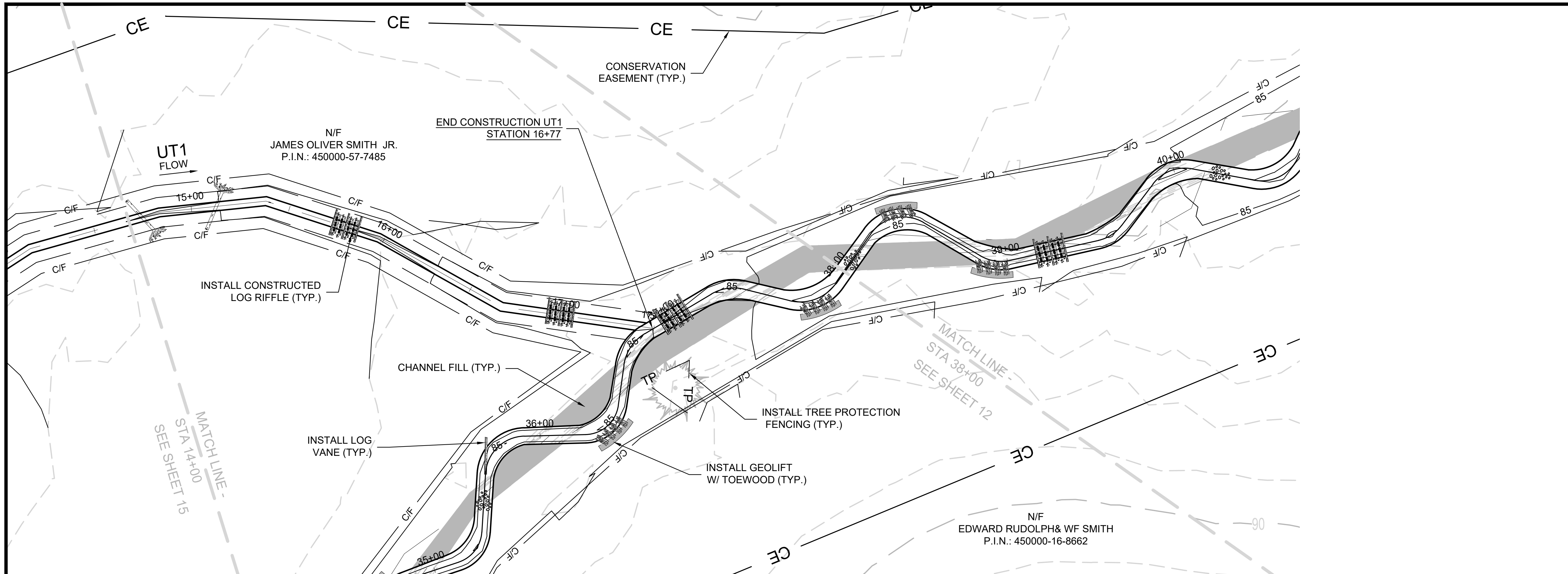
SHEET NAME

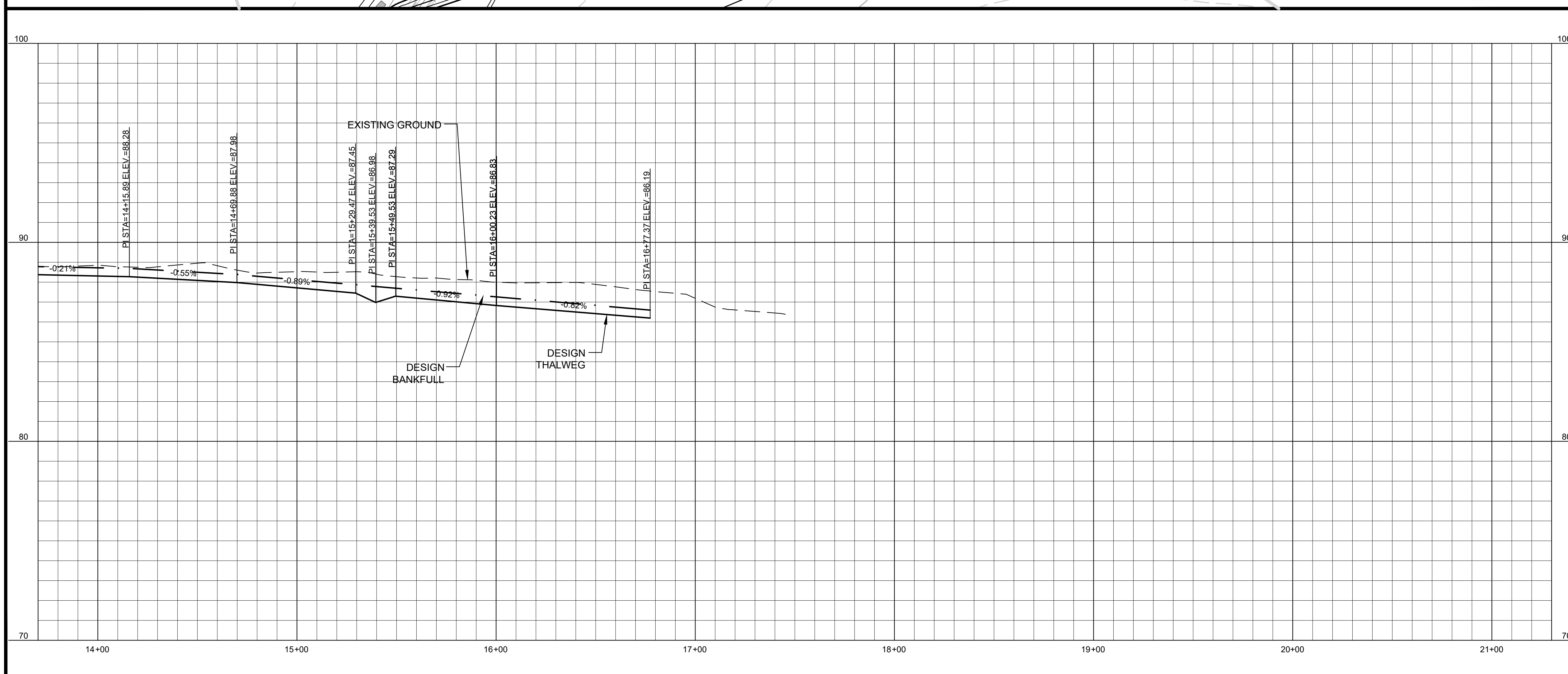
UT2&UT1

PLAN AND PROFILE

SHEET NUMBER

15





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NORTH

30 15 0 30 60

GRAPHIC SCALE

SHEET NAME

UT1

PLAN AND PROFILE

SHEET NUMBER

16

PLANTING NOTES

1. THE FOLLOWING TABLES LIST THE PROPOSED VEGETATION SPECIES SELECTION FOR THE PROJECT REVEGETATION. THE TOTAL PLANTING AREA IS APPROXIMATELY 13.2 ACRES AND WILL VARY BASED ON SITE CONDITIONS AND AREAS DISTRUBED DURING CONSTRUCTION.
2. FINAL VEGETATION SPECIES SELECTION MAY CHANGE DUE TO REFINEMENT OR SPECIES AVAILABILITY AT THE TIME OF PLANTING. SPECIES SUBSTITUTIONS WILL BE COORDINATED BETWEEN ENGINEER AND PLANTING CONTRACTOR PRIOR TO THE PROCUREMENT OF PLANT/SEED STOCK.
3. IN GENERAL, WOODY SPECIES SHALL BE PLANTED AT A DENSITY OF 680 STEMS PER ACRE AND A MINIMUM OF 50 FEET FROM THE TOP OF RESTORED STREAMBANKS AND TO THE REVEGETATION LIMITS. EXACT PLACEMENT OF THE SPECIES WILL BE DETERMINED BY THE CONTRACTOR'S VEGETATION SPECIALIST PRIOR TO SITE PLANTING AND BASED ON THE WETNESS CONDITIONS OF PLANTING LOCATIONS.
4. SUPPLEMENTAL PLANTING ACTIVITIES SHALL BE PERFORMED WITHIN THE CONSERVATION EASEMENT USING NATIVE SPECIES VEGETATION DESCRIBED IN RIPARIAN BUFFER PLANT MIXTURE.
5. ANY INVASIVE SPECIES VEGETATION, SUCH AS CHINESE PRIVET (*LIGUSTRUM SINENSE*) AND MULTIFLORA ROSE (*ROSA MULTIFLORA*) WILL BE INITIALLY TREATED AS DESCRIBED IN THE CONSTRUCTION SPECIFICATIONS PRIOR TO PLANTING ACTIVITIES TO ALLOW NATIVE PLANTS TO BECOME ESTABLISHED WITHIN THE CONSERVATION EASEMENT.
6. LARGER NATIVE TREE SPECIES TO BE PRESERVED WILL BE FLAGGED BY THE ENGINEER PRIOR TO CONSTRUCTION ACTIVITIES. ANY TREES HARVESTED FOR WOODY MATERIAL WILL BE UTILIZED TO PROVIDE BED AND BANK STABILIZATION, COVER AND/OR NESTING HABITAT.
7. ALL DISTURBED AREAS WILL BE STABILIZED USING MULCHING AND SEEDING AS DEFINED IN THE CONSTRUCTION SPECIFICATIONS AND THE APPROVED SEDIMENTATION AND EROSION CONTROL PLANS.

PLANTING SCHEDULE

Botanical Name	Common Name	% Proposed for Planting by Species	Wetland Tolerance
Riparian Buffer Bare Root Plantings – Overstory			
(Proposed 8' x 8' Planting Spacing @ 680 Stems/Acre)			
Betula nigra	River birch	10%	FACW
Fraxinus pennsylvanica	Green ash	3%	FACW
Platanus occidentalis	American sycamore	10%	FACW
Quercus nigra	Water oak	8%	FAC
Liriodendron tulipifera	Tulip tree	10%	FACU
Quercus alba	White oak	6%	FACU
Nyssa biflora	Swamp black gum	8%	OBL
Quercus bicolor	Swamp white oak	8%	FACW
Quercus michauxii	Swamp chestnut oak	8%	FACW
Quercus phellos	Willow oak	8%	FACW
Riparian Buffer Bare Root Plantings – Understory			
(Proposed 8' x 8' Planting Spacing @ 680 Stems/Acre)			
Clethra alnifolia	Sweet pepperbush	3%	FACW
Carpinus caroliniana	Ironwood	3%	FAC
Persea palustris	Red bay	3%	FACW
Eubotrys racemosus	Swamp doghobble	3%	FACW
Magnolia virginiana	Sweetbay magnolia	3%	FACW
Cyrilla racimiflora	Titi	3%	FACW
Itea virginica	Sweetspire	3%	FACW
Riparian Buffer Live Stake Plantings - Streambanks			
(Proposed 2'- 3' Spacing @ Meander Bends and 6'- 8' Spacing @ Riffle Sections)			
Cephalanthus occidentalis	Buttonbush	20%	OBL
Salix sericea	Silky willow	30%	OBL
Salix nigra	Black willow	10%	OBL
Sambucus canadensis	Elderberry	40%	FACW-

TEMPORARY SEEDING SCHEDULE

Planting Dates	Botanical Name	Common Name	Application Rate (lbs/acre)
September to March	*Secale cereale*	Rye Grain (Cool Season)	130
April to August	*Urochloa ramosa*	Browntop Millet (Warm Season)	40

PERMANENT SEEDING SCHEDULE

Botanical Name	Common Name	% Proposed for Planting by Species	Seeding Rate (lb/acre)	Wetland Tolerance
Permanent Herbaceous Seed Mixture – Streambank, Floodplain, Wetlands and Riparian Buffer Areas				
(Proposed Seed Rate @ 15 lbs/acre)				
Andropogon gerardii	Big blue stem	10%	1.50	FAC
Dichanthelium clandestinum	Deer tongue	15%	1.50	FACW
Carex vulpinoidea	Fox sedge	10%	2.25	OBL
Carex lupulina	Hop sedge	5%	2.25	OBL
Elymus virginicus	Virginia wild rye	15%	1.50	FAC
Juncus effusus	Soft rush	15%	2.25	FACW+
Panicum virgatum	Switchgrass	5%	1.50	FACW+
Schizachyrium scoparium	Little blue stem	10%	0.75	FACU
Tripsacum dactyloides	Eastern gamagrass	5%	0.75	FAC+
Sorghastrum nutans	Indiangrass	10%	0.75	FACU

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VERT. SCALE	N/A

SHEET NAME

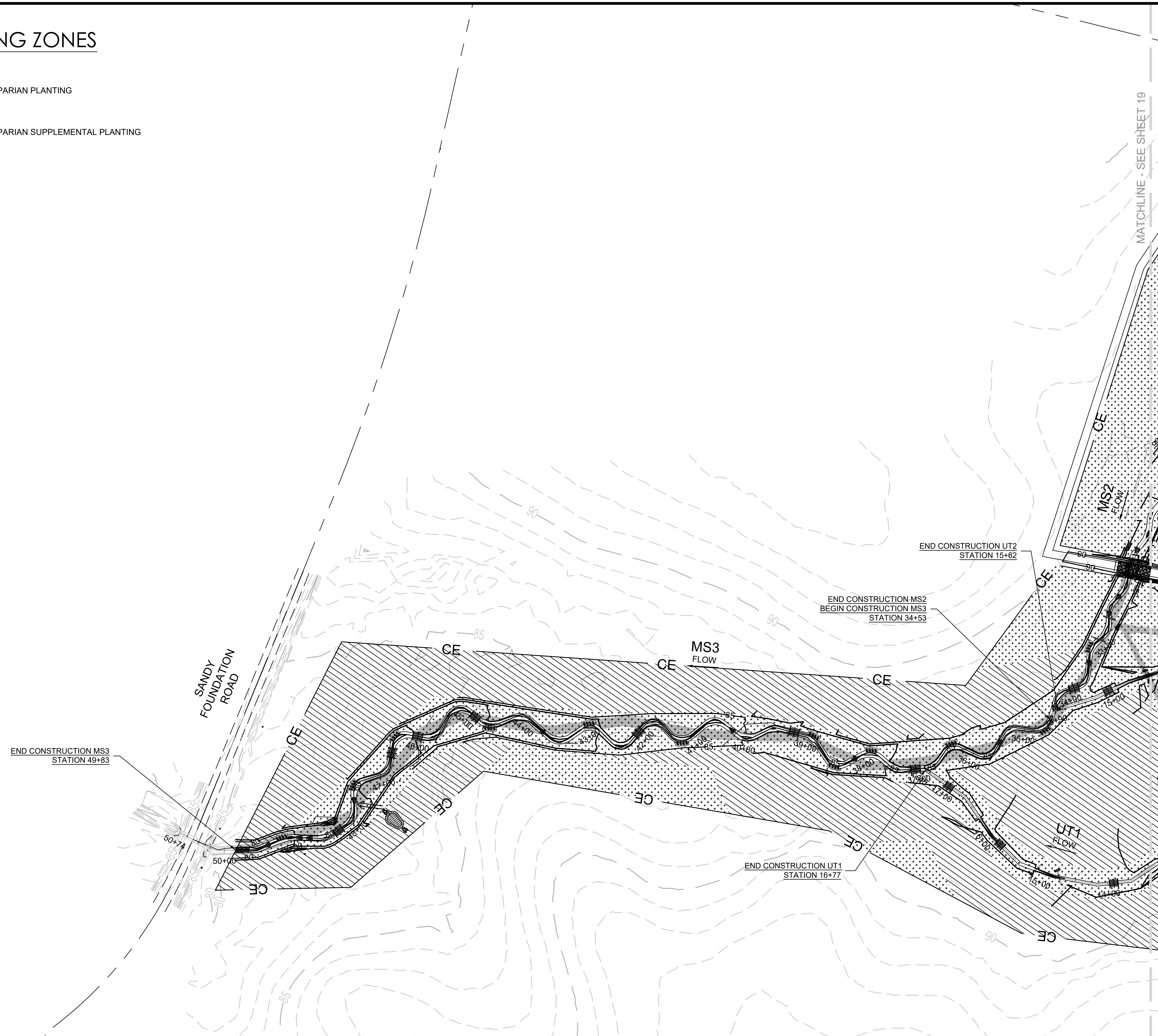
REVEGETATION PLAN

SHEET NUMBER

17

PLANTING ZONES

- RIPARIAN PLANTING
- RIPARIAN SUPPLEMENTAL PLANTING



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NORTH

75 37.5 0 75 150
GRAPHIC SCALE

SHEET NAME

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NORTH

75 37.5 0 75 150
GRAPHIC SCALE

SHEET NAME

REVEGETATION PLAN

SHEET NUMBER

19

Appendix 2 – Site Analysis Data/Supplementary Information

Pre-Construction Gauge Data

Existing Geomorphic Data

Particle Size Distribution

BANCS (BEHI/NBS) Method Estimates

Watershed Information and Site Runoff Volume

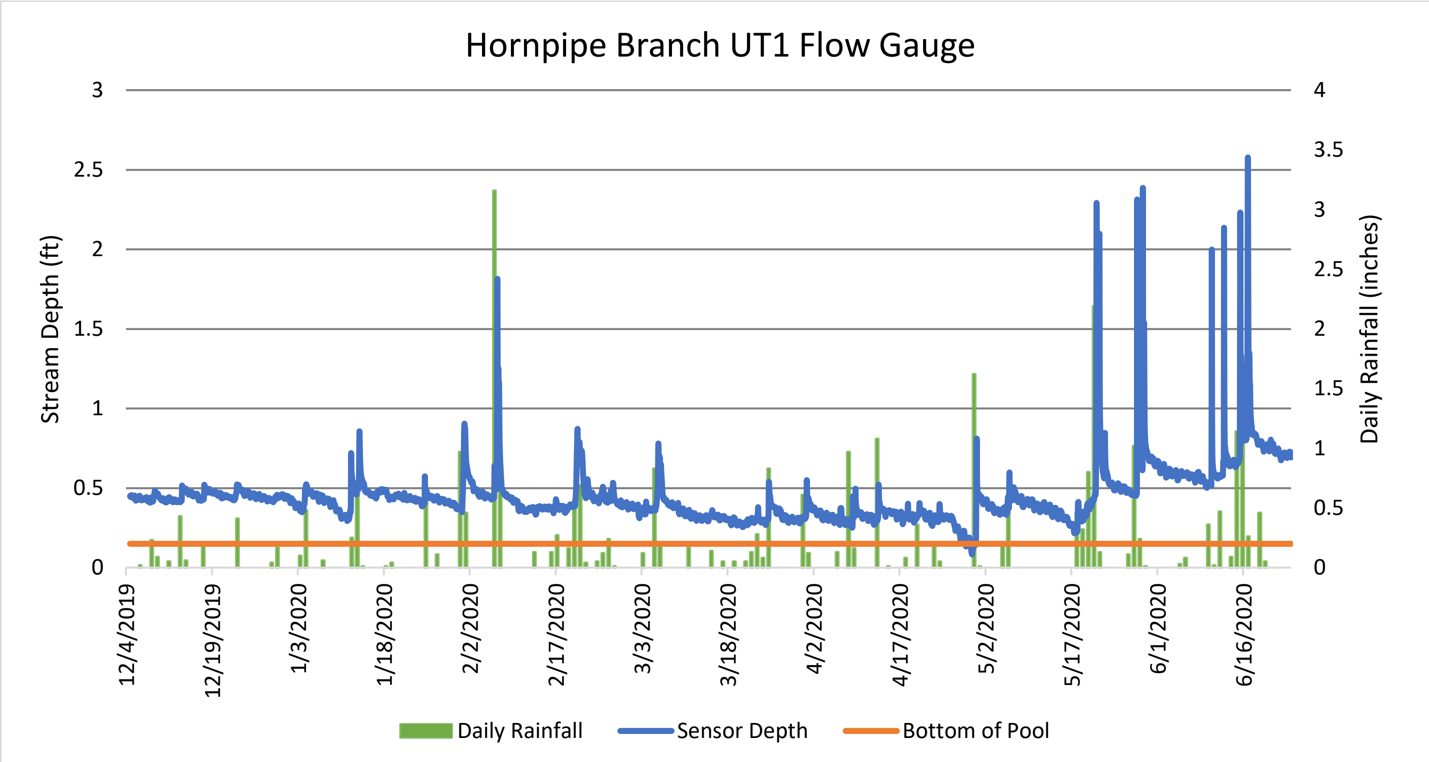
NC Coastal Plain Regional Curve Comparison

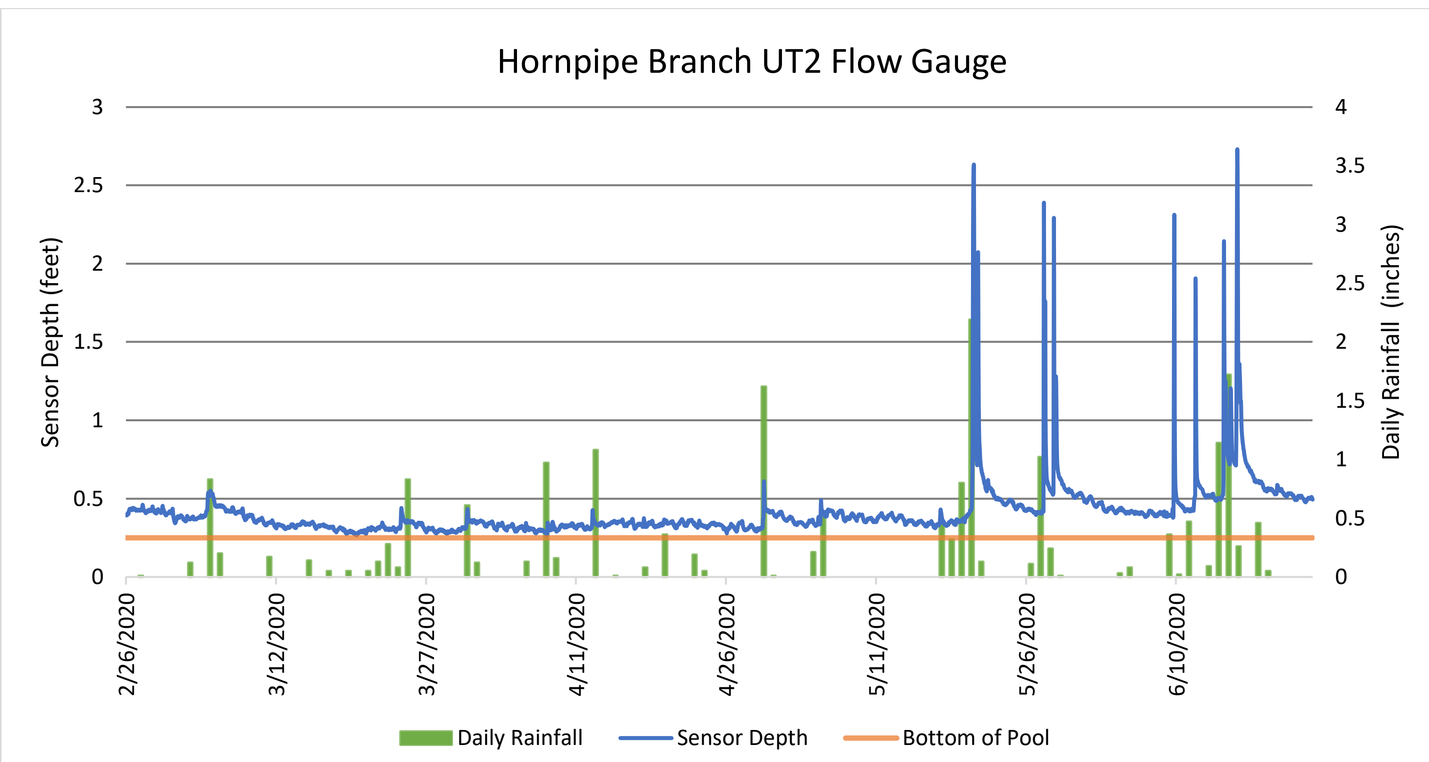
USGS Regression Flow Analysis

Stream Quantification Tool Reach Summary

Design Criteria and Stream Morphology Parameters

Site Photographs


Hornpipe Branch UT1 Flow Gauge
Stream Depth (ft)
Daily Rainfall (inches)
3
2.5
2
1.5
1
0.5
0
4
3.5
3
2.5
2
1.5
1
0.5
0
12/4/2019
12/19/2019
1/3/2020
1/18/2020
2/2/2020
2/17/2020
3/3/2020
3/18/2020
4/2/2020
4/17/2020
5/2/2020
5/17/2020
6/1/2020
6/16/2020
Daily Rainfall
Sensor Depth
Bottom of Pool


Hornpipe Branch UT2 Flow Gauge
Sensor Depth (feet)
Daily Rainfall (inches)
3
2.5
2
1.5
1
0.5
0
4
3.5
3
2.5
2
1.5
1
0.5
0
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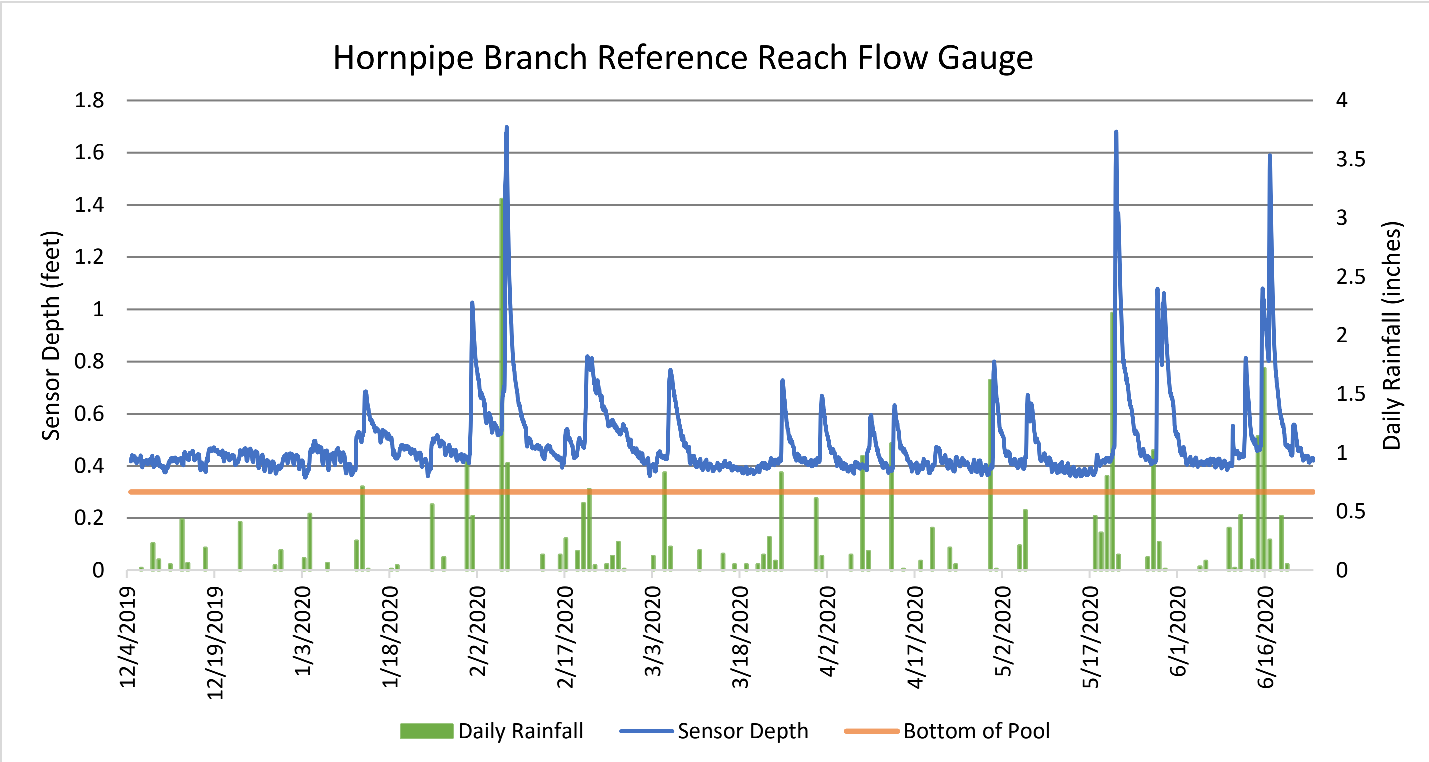
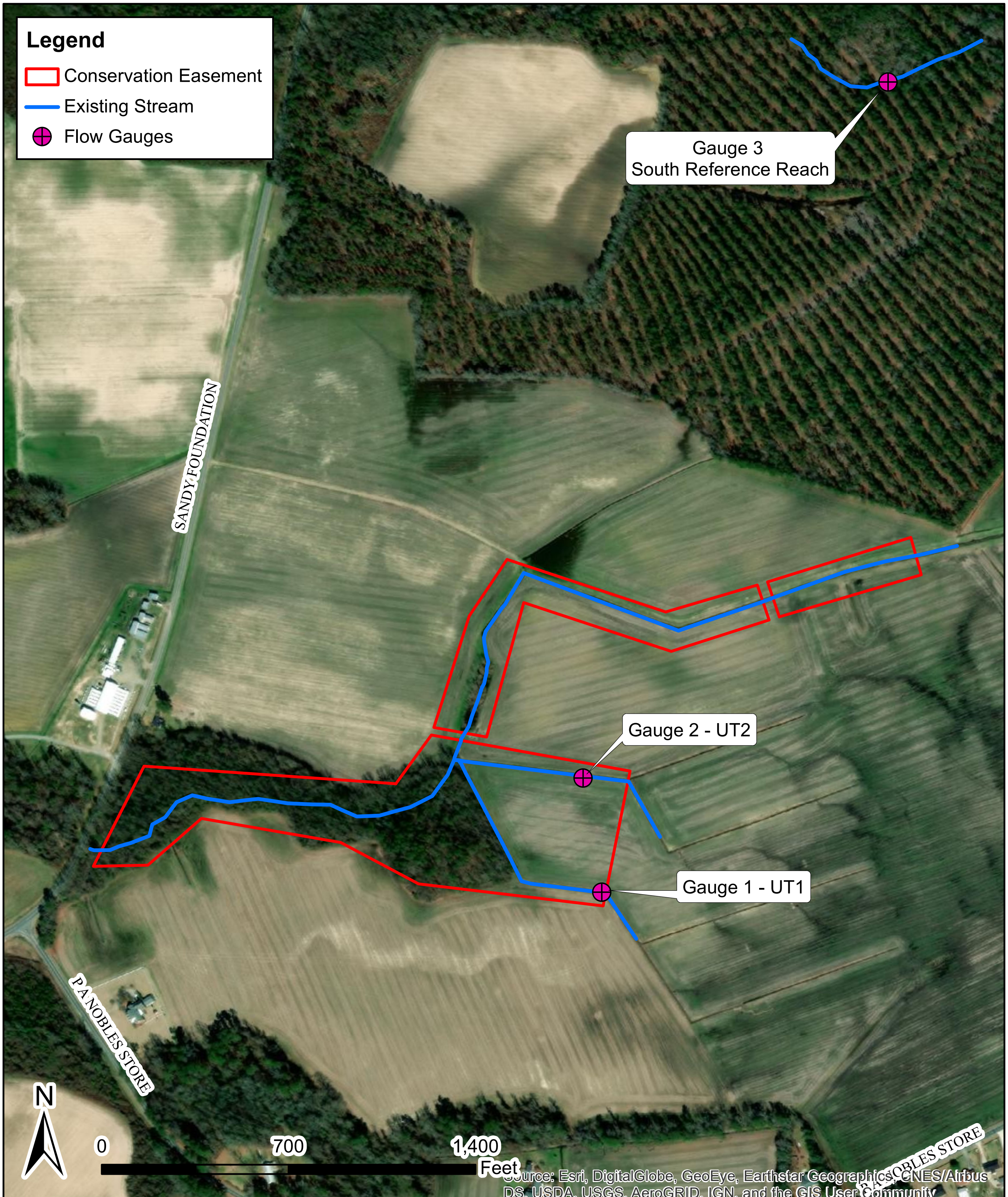
3/12/2020
3/27/2020
4/11/2020
4/26/2020
5/11/2020
5/26/2020
6/10/2020
Daily Rainfall
Sensor Depth
Bottom of Pool



Hornpipe Branch Reference Reach Flow Gauge
Sensor Depth (feet)
Daily Rainfall (inches)
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
4
3.5
3
2.5
2
1.5
1
0.5
0
12/4/2019
12/19/2019
1/3/2020
1/18/2020
2/2/2020
2/17/2020
3/3/2020
3/18/2020
4/2/2020
4/17/2020
5/2/2020
5/17/2020
6/1/2020
6/16/2020
Daily Rainfall
Sensor Depth
Bottom of Pool



WATER & LAND™ SOLUTIONS

Hornpipe Branch Tributaries Mitigation Project

Existing Well Locations

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE 1

RIVERMORPH PROFILE SUMMARY

River Name: Hornpipe Branch
Reach Name: South Reference Reach
Profile Name: South RefReach Long Pro
Survey Date: 01/08/2020

Survey Data

DIST	CH	WS	BKF	P1	P2	P3	P4
0	94.63						
3	93.65						
4.9	94.65						
7.3	93.69						
11.4	93.75						
16	93.85						
19.5	93.45						
26	93.85						
32	94.2						
36	94.23						
42	93.6						
50	93.55						
57	93.95						
64	93.8						
66.7	93.1						
69	93.55						
73	92.65						
79	92.51						
84	92.8						
90	93.05						
100	92.85						
105	92.8						
106	92.55						
109.5	92.71						
113	92.68						
120	92.8						
123	92.79						
123.5	92.3						
125	92.8						
127	92.76						
131	92						
139	92.58						
148	92.5						
158	92.3						
164	92.2						
168	92.81						
172	91.9						
176.5	91.37						
180	90.55						
189	91						
193	91.4						
198	91.53						

Cross Section / Bank Profile Locations

Name	Type	Profile Station
XS @ STA 100.8	Riffle XS	100.8

Measurements from Graph

Bankfull Slope: 0

Variable	Min	Avg	Max
S riffle	0	0	0
S pool	0	0	0
S run	0	0	0
S glide	0	0	0
S step	0	0	0
P - P	0	0	0
Pool length	0	0	0
Riffle length	0	0	0
Dmax riffle	0	0	0
Dmax pool	0	0	0
Dmax run	0	0	0
Dmax glide	0	0	0
Dmax step	0	0	0
Low bank ht	0	0	0

Length and depth measurements in feet, slopes in ft/ft.

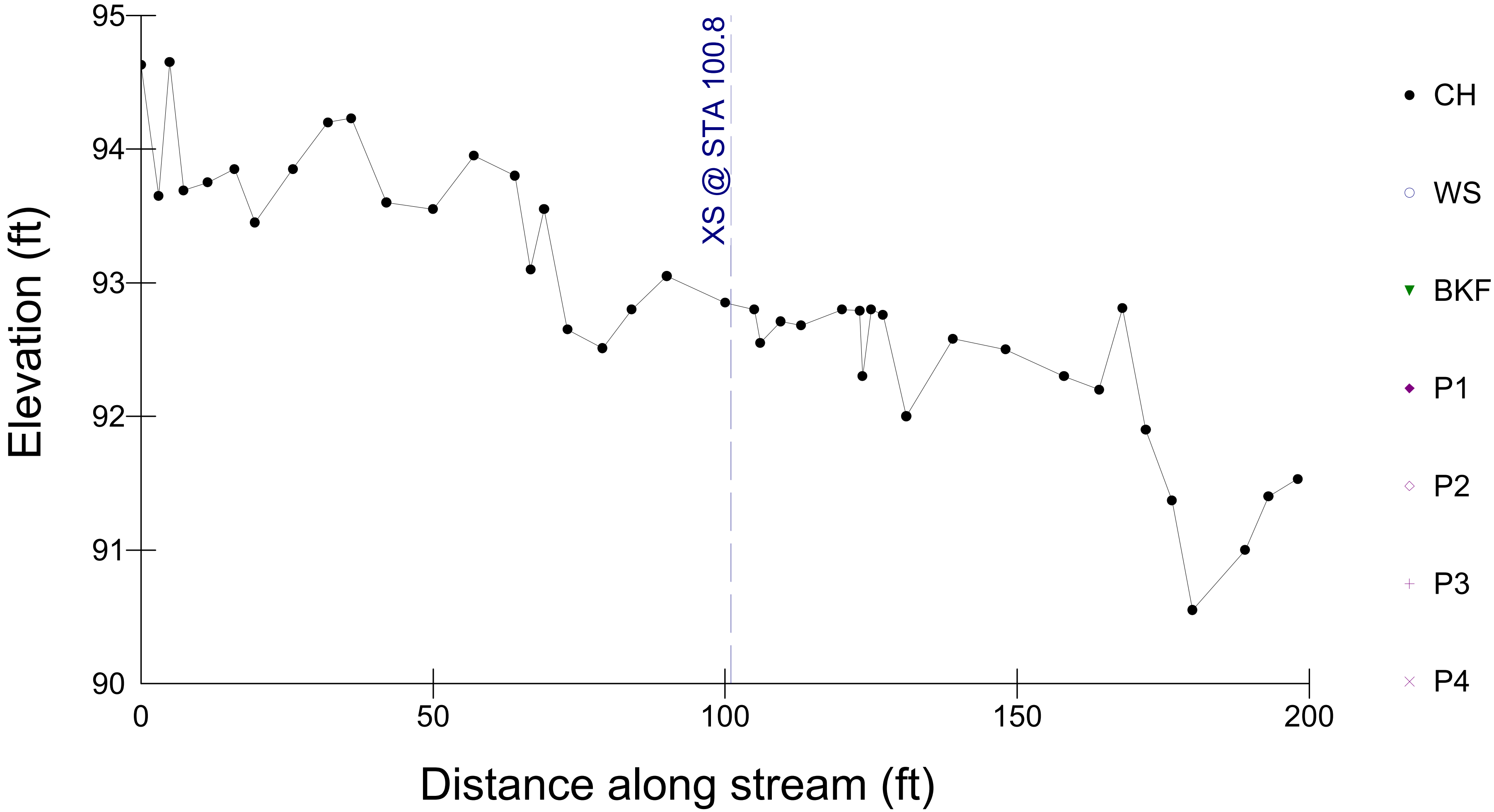
RIVERMORPH PROFILE SUMMARY

Notes

River Name: Hornpipe Branch
Reach Name: South Reference Reach
Profile Name: South RefReach Long Pro
Survey Date: 01/08/2020

DIST	Note
3	TW# max p
4.9	log inv
7.3	TW# max p
11.4	TOP RIF
16	END RIF
19.5	TW# max p
26	Top RIF
32	TW#
36	step
42	TOP RIF
50	TW#
57	END RIF
64	TW#
66.7	TW# max p
69	TOP RIF
73	TW# pool
79	TW# pool
84	TW#
90	TOP RIF
100	TW# rif
105	END RIF
106	TW# max pool
109.5	TW#
113	TW#
120	TW#
123	END RIF
123.5	TW# max pool
125	TOP RIF
127	END RIF
131	TW# max pool
139	TOP RIF
148	TW# riff
158	TW#
164	TW#
168	step/head pool
172	TW#
176.5	TW# max pool
180	TW#
189	TW 8.42
193	TOP RIF
198	END RIF

South RefReach Long Pro



RIVERMORPH CROSS SECTION SUMMARY

River Name: Hornpipe Branch
Reach Name: South Reference Reach
Cross Section Name: XS @ STA 100.8
Survey Date: 01/08/2020

Cross Section Data Entry

BM Elevation: 50 ft
Backsight Rod Reading: 50 ft

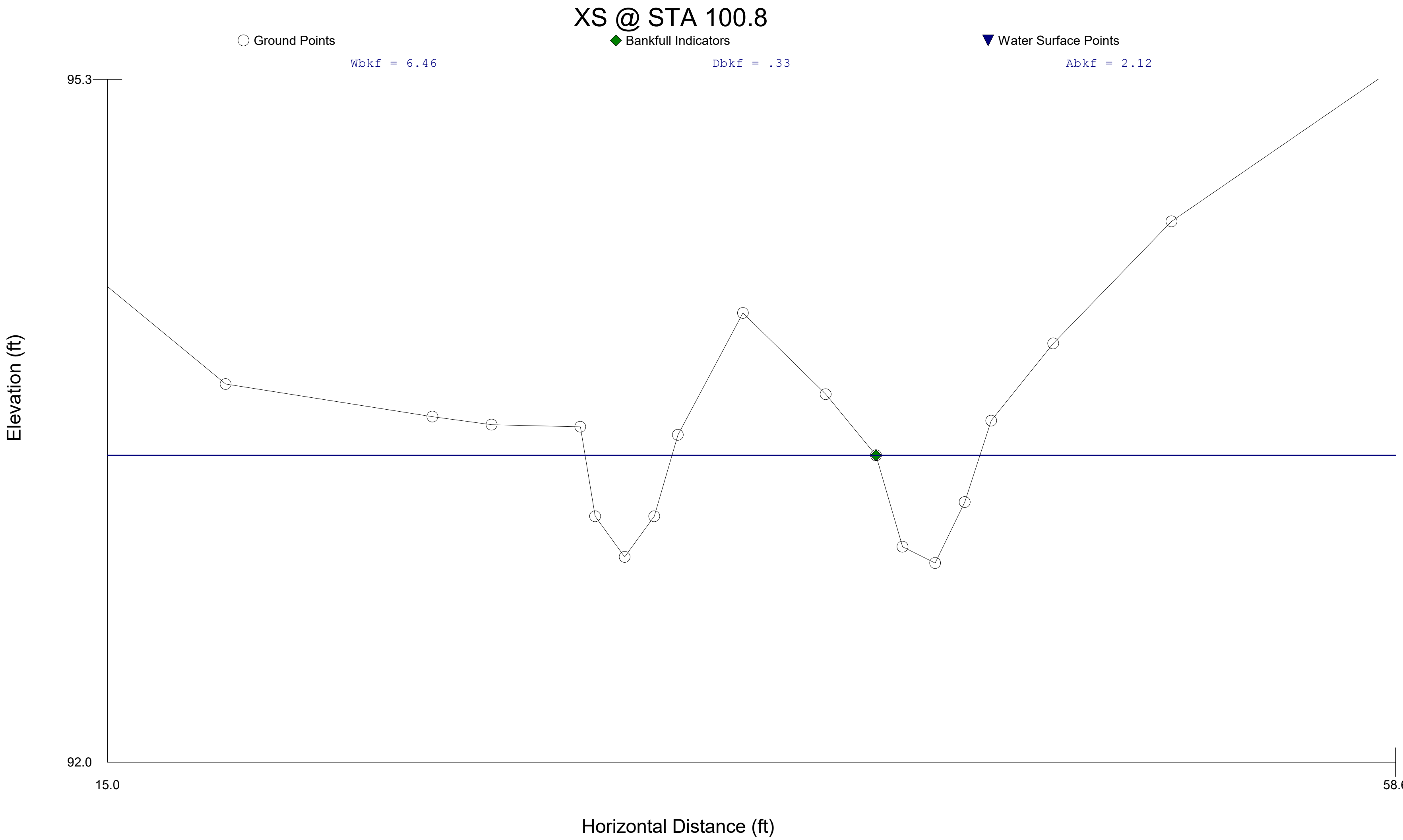
TAPE	FS	ELEV	NOTE
0	4.21	95.79	LEP
6	5.22	94.78	
14	5.55	94.45	
19	6.15	93.85	
26	6.31	93.69	
28	6.35	93.65	
31	6.36	93.64	
31.5	6.8	93.2	
32.5	7	93	
33.5	6.8	93.2	
34.3	6.4	93.6	
36.5	5.8	94.2	high spot between braided channel
39.3	6.2	93.8	
41	6.5	93.5	BKF - LB
41.9	6.95	93.05	LEC
43	7.03	92.97	TW
44	6.73	93.27	REC
44.9	6.33	93.67	RB
47	5.95	94.05	FP
51	5.35	94.65	
60	4.45	95.55	
65	4.22	95.78	REP

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	94.03	94.03	94.03
Bankfull Elevation (ft)	93.5	93.5	93.5
Floodprone Width (ft)	27.58	-----	-----
Bankfull Width (ft)	6.46	3.23	10.13
Entrenchment Ratio	4.27	-----	-----
Mean Depth (ft)	0.33	0.32	0.34
Maximum Depth (ft)	0.53	0.5	0.53
Width/Depth Ratio	19.58	10.09	29.79
Bankfull Area (sq ft)	2.12	0.94	1.18
Wetted Perimeter (ft)	6.88	3.16	3.72
Hydraulic Radius (ft)	0.31	0.3	0.32
Begin BKF Station	31.16	31.16	41
End BKF Station	44.52	34.1	44.52

Entrainment Calculations

Entrainment Formula: Rosgen Modified Shields Curve


XS @ STA 100.8
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 6.46
Dbkf = .33
Abkf = 2.12
95.3
92.0
15.0
58.6
Elevation (ft)
Horizontal Distance (ft)

RIVERMORPH CROSS SECTION SUMMARY

River Name: Hornpipe Branch
Reach Name: MS3
Cross Section Name: X1
Survey Date: 03/14/2018

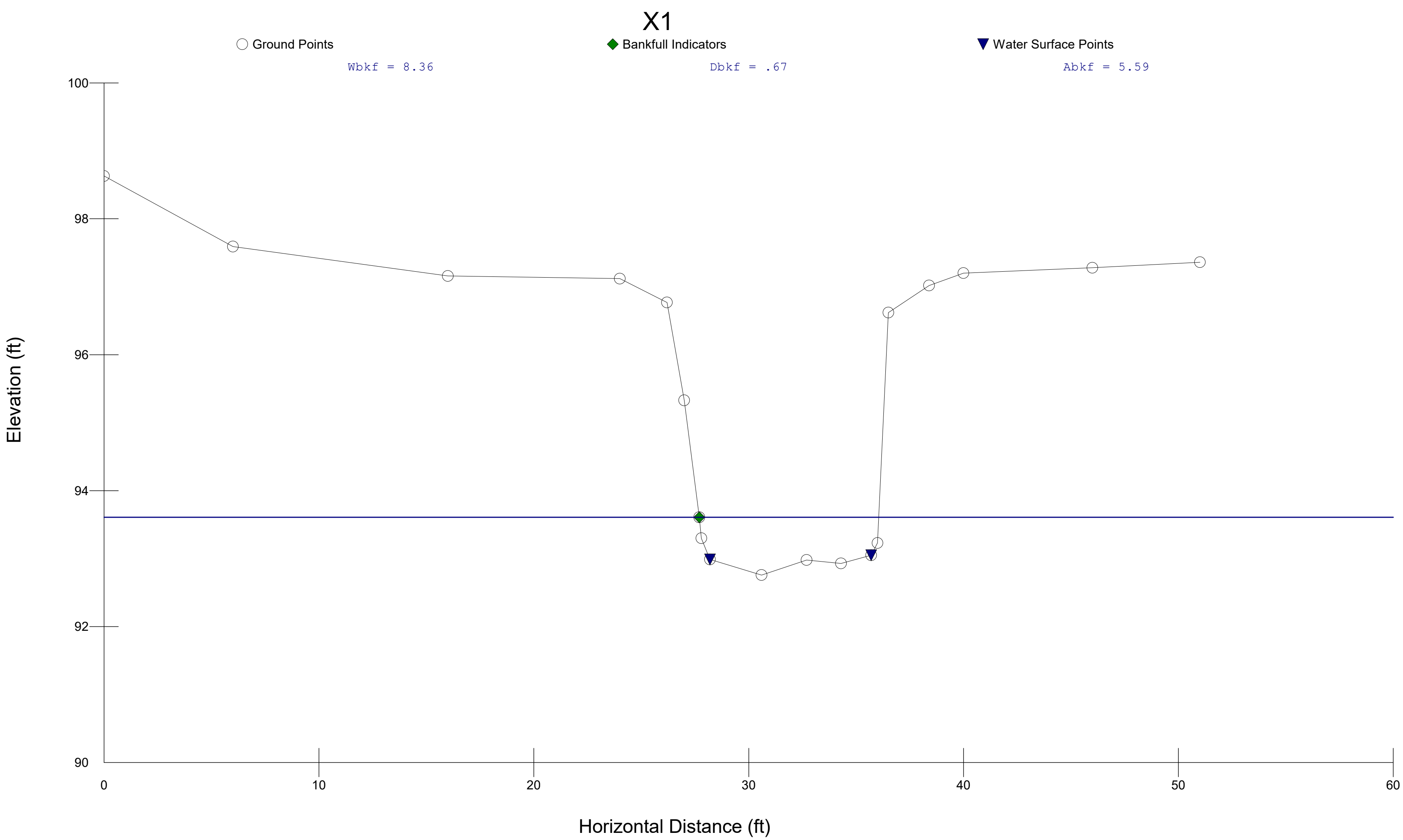
Cross Section Data Entry

BM Elevation: 50 ft
Backsight Rod Reading: 50 ft

TAPE	FS	ELEV	NOTE
0	1.37	98.63	LEP
6	2.41	97.59	NG
16	2.84	97.16	NG
24	2.88	97.12	BRK
26.2	3.23	96.77	LB TOB
27	4.67	95.33	BRK
27.7	0	93.61	BKF
27.8	6.7	93.3	BRK
28.2	7.01	92.99	LEW
30.6	7.24	92.76	TW
32.7	7.02	92.98	CH
34.3	7.07	92.93	CH
35.7	6.95	93.05	REW
36	6.77	93.23	TOE
36.5	3.38	96.62	BRK
38.4	2.98	97.02	RB TOB
40	2.8	97.2	BRK
46	2.72	97.28	NG
51	2.64	97.36	REP

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	94.44	94.44	94.44
Bankfull Elevation (ft)	93.6	93.6	93.6
Floodprone Width (ft)	8.82	-----	-----
Bankfull Width (ft)	8.35	4.16	4.19
Entrenchment Ratio	1.06	-----	-----
Mean Depth (ft)	0.66	0.7	0.62
Maximum Depth (ft)	0.84	0.84	0.71
Width/Depth Ratio	12.65	5.94	6.76
Bankfull Area (sq ft)	5.5	2.91	2.59
Wetted Perimeter (ft)	9.07	5.21	5.28
Hydraulic Radius (ft)	0.61	0.56	0.49
Begin BKF Station	27.7	27.7	31.86
End BKF Station	36.05	31.86	36.05


X1
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 8.36
Dbkf = .67
Abkf = 5.59
Elevation (ft)
Horizontal Distance (ft)
100
98
96
94
92
90
0
10
20
30
40
50
60

RIVERMORPH CROSS SECTION SUMMARY

River Name: Hornpipe Branch
Reach Name: UT1
Cross Section Name: X2
Survey Date: 03/14/2018

Cross Section Data Entry

BM Elevation: 50 ft
Backsight Rod Reading: 50 ft

TAPE	FS	ELEV	NOTE
0	4.48	95.52	LEP
4	3.99	96.01	NG
8.5	2.64	97.36	Spoil
14	4.74	95.26	LB TOB
18	7.4	92.6	BKF bench
19.9	7.53	92.47	BRK
20.4	7.58	92.42	BRK
20.8	8.26	91.74	LEW
21.6	8.36	91.64	TW
22	8.23	91.77	REW
22.5	6.66	93.34	BRK
25.6	5.21	94.79	RB TOB
37.4	4.58	95.42	REP

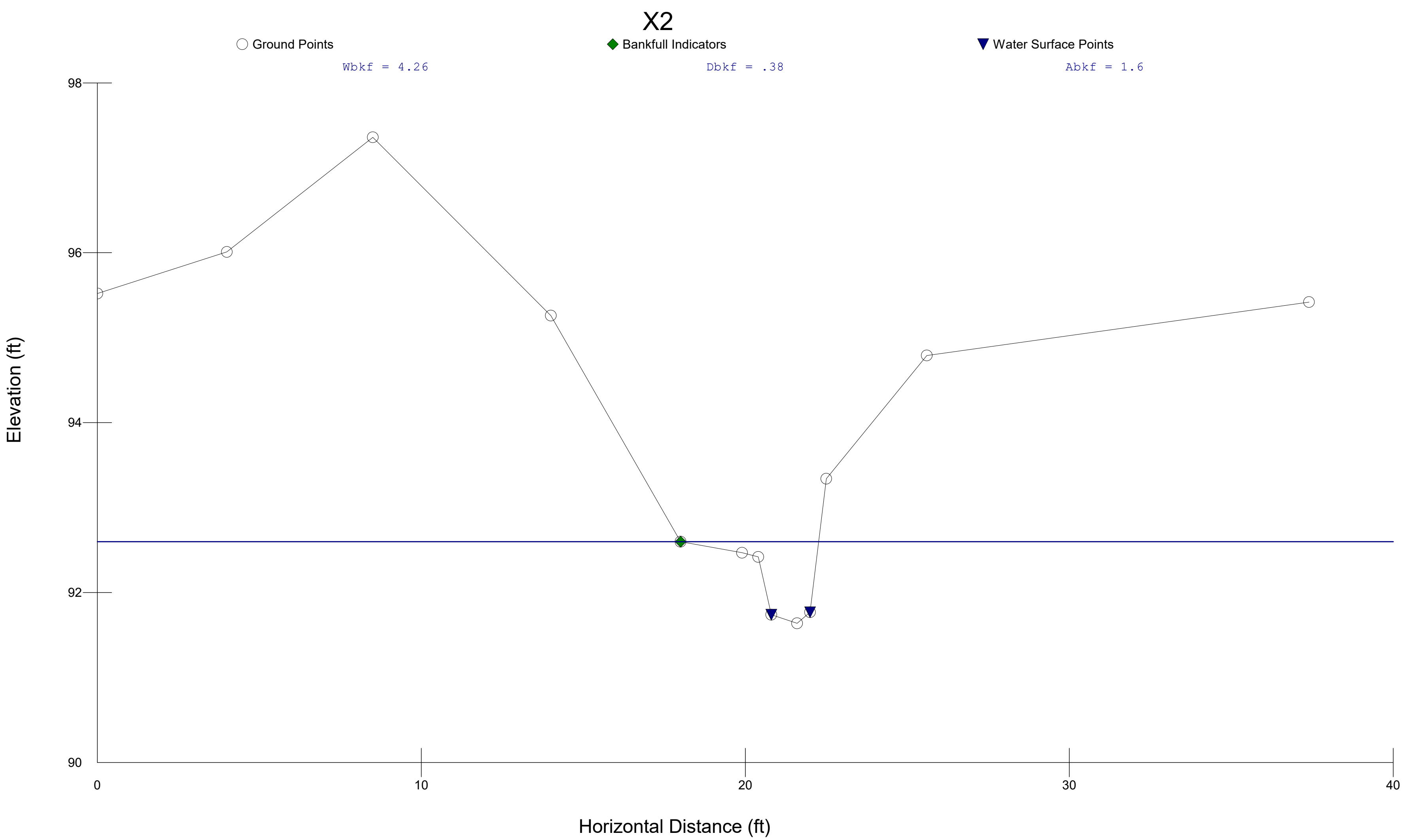
Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	93.56	93.56	93.56
Bankfull Elevation (ft)	92.6	92.6	92.6
Floodprone Width (ft)	6.41	-----	-----
Bankfull Width (ft)	4.26	2.13	2.13
Entrenchment Ratio	1.5	-----	-----
Mean Depth (ft)	0.38	0.07	0.68
Maximum Depth (ft)	0.96	0.15	0.96
Width/Depth Ratio	11.21	29.07	3.13
Bankfull Area (sq ft)	1.6	0.16	1.45
Wetted Perimeter (ft)	5.29	2.29	3.31
Hydraulic Radius (ft)	0.3	0.07	0.44
Begin BKF Station	18	18	20.13
End BKF Station	22.26	20.13	22.26

Entrainment Calculations

Entrainment Formula: Shields Curve

	Channel	Left Side	Right Side
Slope	0	0	0
Shear Stress (lb/sq ft)			
Movable Particle (mm)			



X2
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 4.26
Dbkf = .38
Abkf = 1.6
98
96
94
92
90
Elevation (ft)
0
10
20
30
40
Horizontal Distance (ft)

RIVERMORPH CROSS SECTION SUMMARY

River Name: Hornpipe Branch
Reach Name: UT2
Cross Section Name: X3
Survey Date: 03/14/2018

Cross Section Data Entry

BM Elevation: 50 ft
Backsight Rod Reading: 50 ft

TAPE	FS	ELEV	NOTE
0	4.86	95.14	LEP
17	5.03	94.97	LB
20.4	6.93	93.07	BRK
20.52	0	92.62	BKF
20.6	7.72	92.28	LEW
21.9	8.04	91.96	TW
22.7	7.66	92.34	REW
28	4.97	95.03	RB
43.2	4.63	95.37	REP

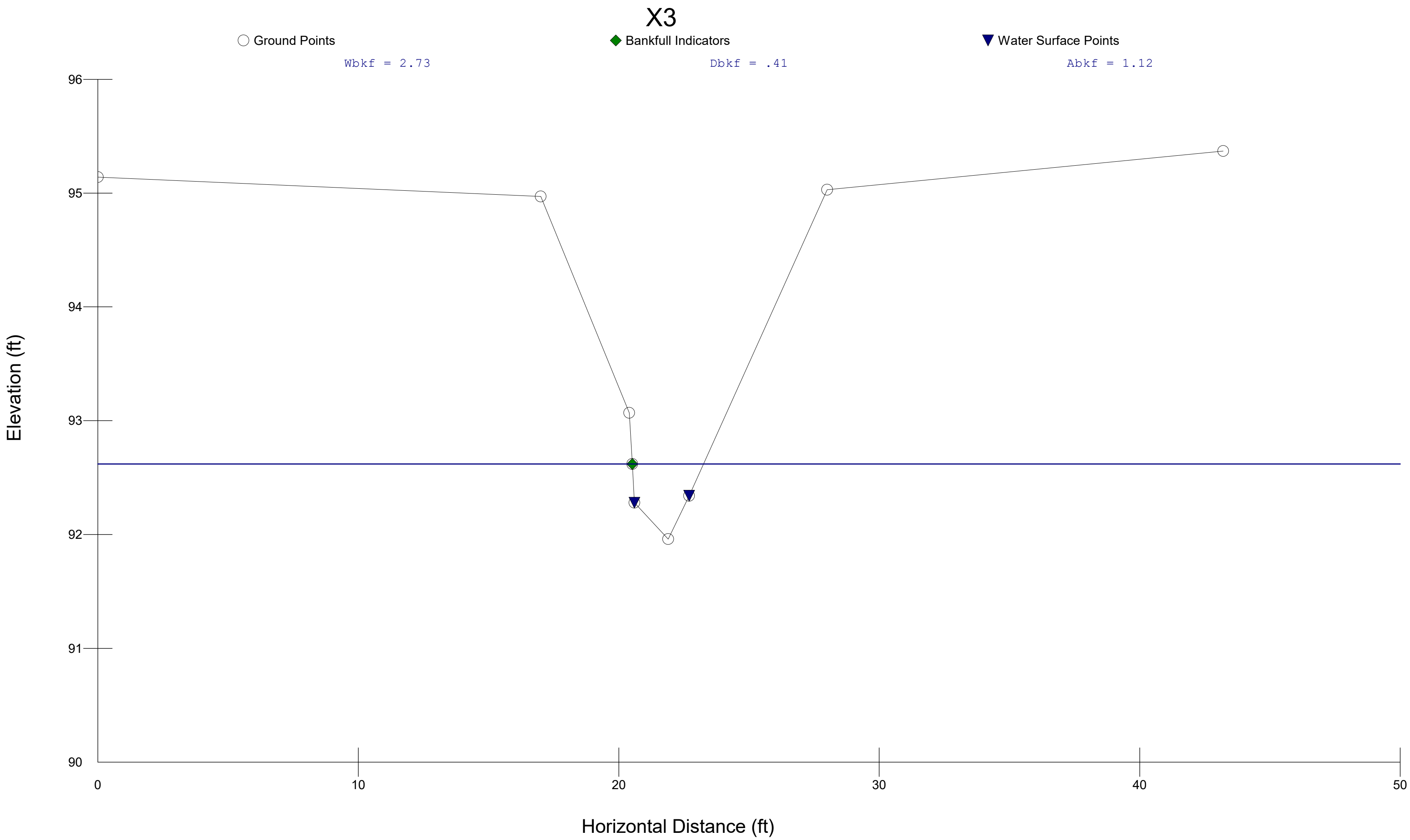
Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	93.28	93.28	93.28
Bankfull Elevation (ft)	92.62	92.62	92.62
Floodprone Width (ft)	4.53	-----	-----
Bankfull Width (ft)	2.73	1.12	1.61
Entrenchment Ratio	1.66	-----	-----
Mean Depth (ft)	0.41	0.45	0.38
Maximum Depth (ft)	0.66	0.6	0.66
Width/Depth Ratio	6.66	2.51	4.24
Bankfull Area (sq ft)	1.12	0.5	0.62
Wetted Perimeter (ft)	3.19	2.02	2.37
Hydraulic Radius (ft)	0.35	0.25	0.26
Begin BKF Station	20.52	20.52	21.64
End BKF Station	23.25	21.64	23.25

Entrainment Calculations

Entrainment Formula: Rosgen Modified Shields Curve

	Channel	Left Side	Right Side
Slope	0	0	0
Shear Stress (lb/sq ft)			
Movable Particle (mm)			


X3
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 2.73
Dbkf = .41
Abkf = 1.12
Elevation (ft)
96
95
94
93
92
91
90
0
10
20
30
40
50
Horizontal Distance (ft)

RIVERMORPH CROSS SECTION SUMMARY

River Name: Hornpipe Branch
Reach Name: MS2
Cross Section Name: X4
Survey Date: 01/15/2020

Cross Section Data Entry

BM Elevation: 50 ft
Backsight Rod Reading: 50 ft

TAPE	FS	ELEV	NOTE
0	4.68	95.32	LEP
12	4.41	95.59	BERM
14.5	4.79	95.21	LB TOB
17.8	6.74	93.26	BKF BRK
18	7.57	92.43	LEW
20	8.05	91.95	TW
21.8	7.6	92.4	REW
22.5	6.27	93.73	BRK
25	5.12	94.88	RB TOB
29	4.61	95.39	BRK
40	4.65	95.35	REP

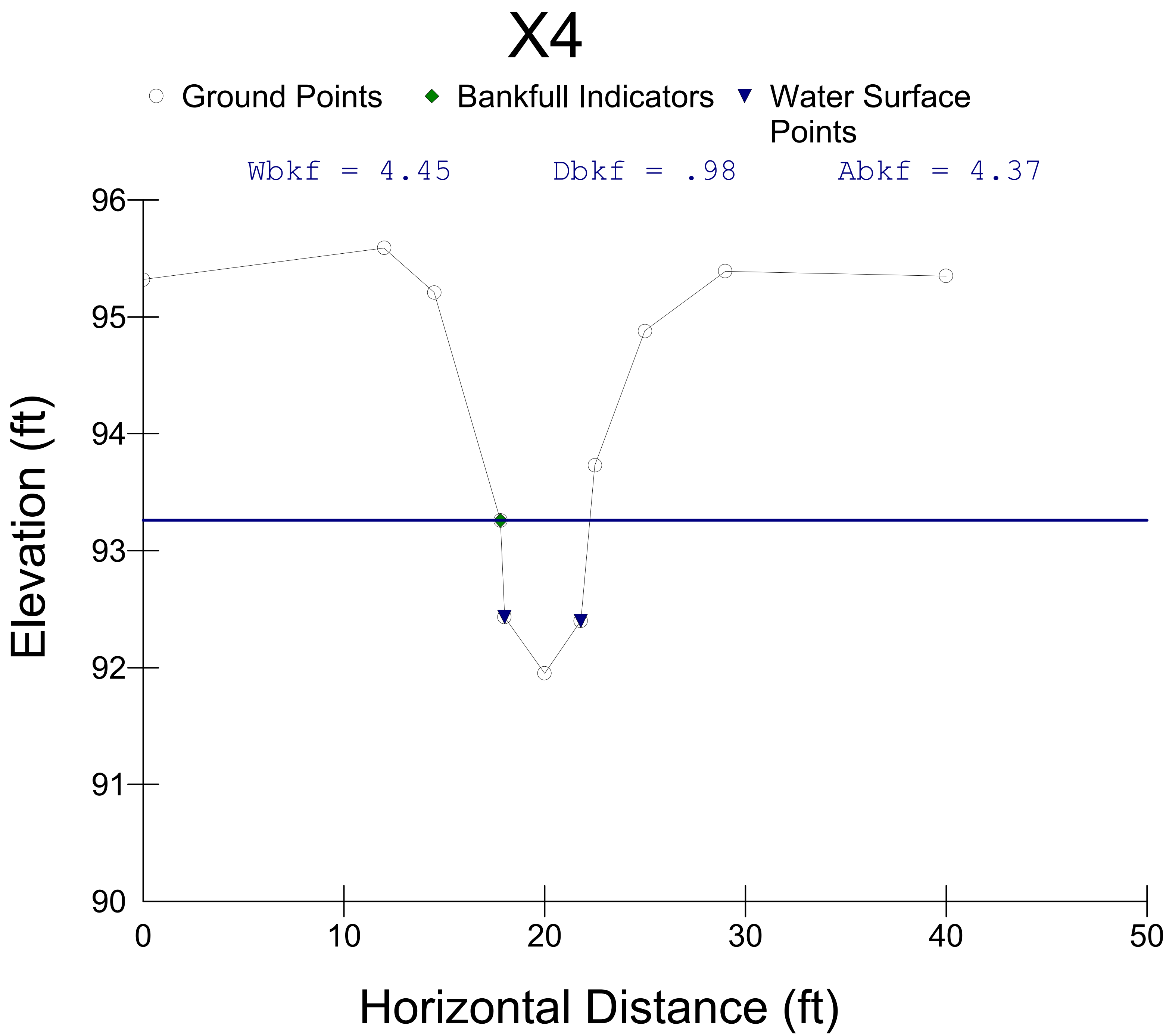
Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	94.57	94.57	94.57
Bankfull Elevation (ft)	93.26	93.26	93.26
Floodprone Width (ft)	8.74	-----	-----
Bankfull Width (ft)	4.45	2.23	2.22
Entrenchment Ratio	1.96	-----	-----
Mean Depth (ft)	0.98	1.01	0.95
Maximum Depth (ft)	1.31	1.31	1.3
Width/Depth Ratio	4.54	2.2	2.34
Bankfull Area (sq ft)	4.37	2.26	2.11
Wetted Perimeter (ft)	5.74	4.24	4.1
Hydraulic Radius (ft)	0.76	0.53	0.51
Begin BKF Station	17.8	17.8	20.03
End BKF Station	22.25	20.03	22.25

Entrainment Calculations

Entrainment Formula: Shields Curve

	Channel	Left Side	Right Side
Slope	0	0	0
Shear Stress (lb/sq ft)			
Movable Particle (mm)			


X4
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 4.45
Dbkf = .98
Abkf = 4.37
Elevation (ft)
Horizontal Distance (ft)
96
95
94
93
92
91
90
0
10
20
30
40
50

RIVERMORPH CROSS SECTION SUMMARY

River Name: Hornpipe Branch
Reach Name: MS1
Cross Section Name: X5
Survey Date: 01/15/2020

Cross Section Data Entry

BM Elevation: 50 ft
Backsight Rod Reading: 50 ft

TAPE	FS	ELEV	NOTE
0	5.21	94.79	LEP
14	4.75	95.25	LB TOB
16.5	0	93.02	BKF
17.3	7.74	92.26	LEW
19.4	8.14	91.86	TW
20.5	7.82	92.18	REW
21.7	6.75	93.25	BRK
25.6	4.87	95.13	RB TOB
42.7	4.86	95.14	REP

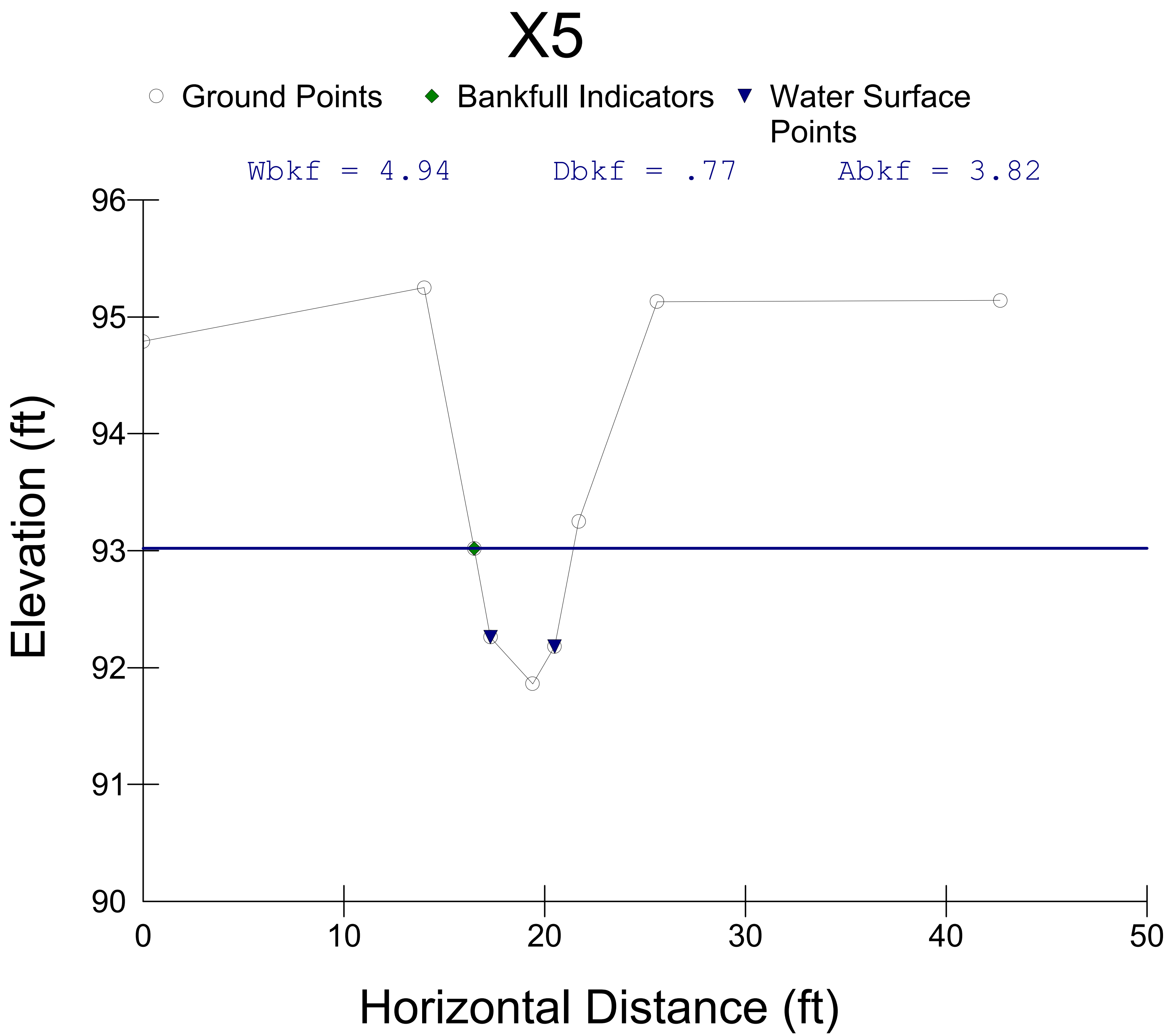
Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	94.18	94.18	94.18
Bankfull Elevation (ft)	93.02	93.02	93.02
Floodprone Width (ft)	8.43	-----	-----
Bankfull Width (ft)	4.94	2.45	2.49
Entrenchment Ratio	1.71	-----	-----
Mean Depth (ft)	0.77	0.74	0.8
Maximum Depth (ft)	1.16	1.07	1.16
Width/Depth Ratio	6.42	3.3	3.11
Bankfull Area (sq ft)	3.82	1.82	2
Wetted Perimeter (ft)	5.65	3.86	3.94
Hydraulic Radius (ft)	0.68	0.47	0.51
Begin BKF Station	16.5	16.5	18.95
End BKF Station	21.44	18.95	21.44

Entrainment Calculations

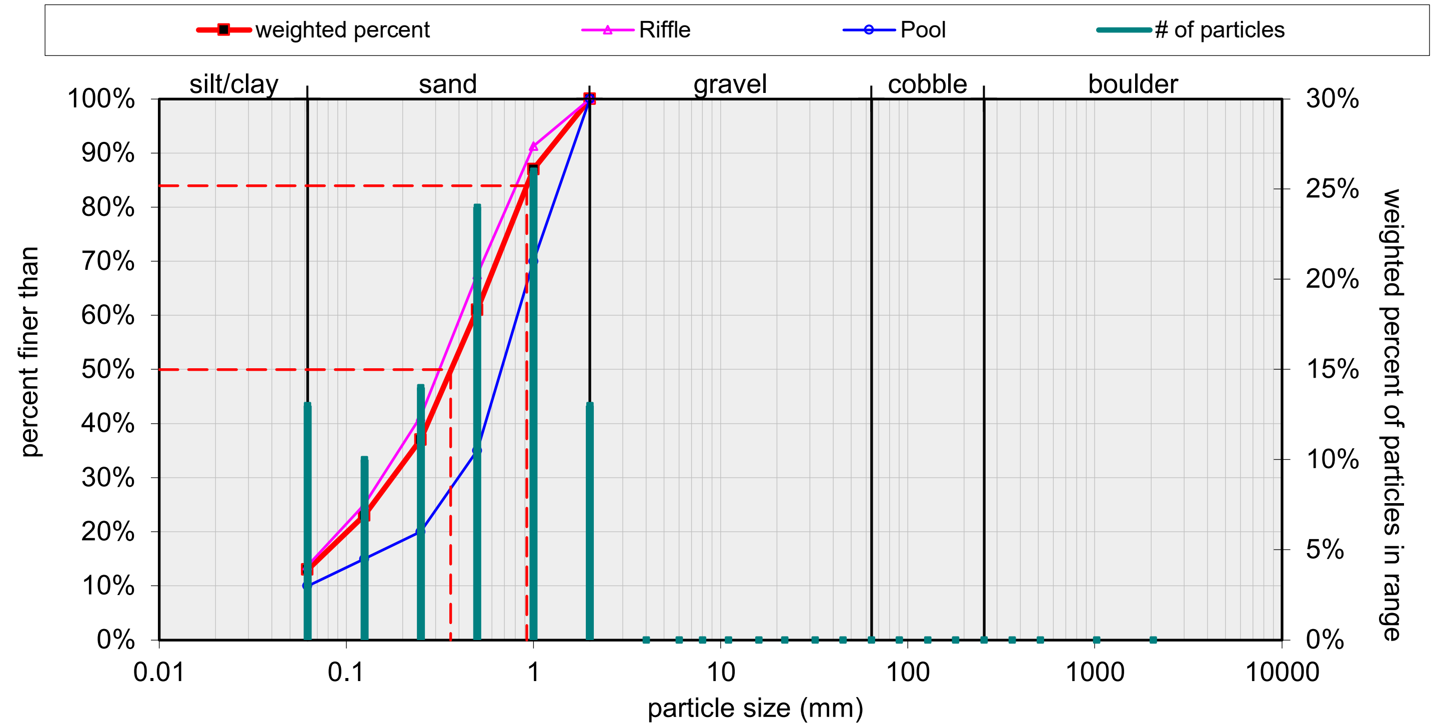
Entrainment Formula: Rosgen Modified Shields Curve

	Channel	Left Side	Right Side
Slope	0	0	0
Shear Stress (lb/sq ft)			
Movable Particle (mm)			


X5
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 4.94
Dbkf = .77
Abkf = 3.82
96
95
94
93
92
91
90
0
10
20
30
40
50
Elevation (ft)
Horizontal Distance (ft)

Sediment Sample, Hornpipe MS3

80% riffle   20% pool



Size (mm)	
D16	0.077
D35	0.23
D50	0.36
D65	0.56
D84	0.92
D95	1.5

Size Distribution	
mean	0.3
dispersion	3.6
skewness	-0.13

Type	
silt/clay	13%
sand	87%
gravel	0%
cobble	0%
boulder	0%

BANCS Method Calcs Appendix 2

Location: Hornpipe, MS1 Field Crew: K. VanStell, C. Manner Date: 1/8/2020

SEDIMENT LOADING ASSESSMENT SHEET

LEFT BANK							RIGHT BANK					
A	B	C	D	E	F		A	B	C	D	E	F
BEHI	**NBS**	**STUDY BANK HEIGHT**	**FEET/YR (from curve)**	**DISTANCE (note station for detailed design needs)**	**TOTAL FT³/yr =(C×D×E)**	**STA**	**BEHI**	**NBS**	**STUDY BANK HEIGHT**	**FEET/YR (from curve)**	**DISTANCE (note station for detailed design needs)**	**TOTAL FT³/yr =(C×D×E)**
Low-Mod	V. Low	3.7	0.03	830	92.1	1830	Low-Mod	V. Low	3.3	0.03	830	82.2
Low-Mod	V. Low	4.9	0.03	2000	294.0	3830	Low-Mod	V. Low	2.0	0.03	2000	120.0
Low-Mod	V. Low	3.8	0.03	740	84.4	4570	Low-Mod	V. Low	3.6	0.03	740	79.9
				TOTAL FT³/YR	470.5						TOTAL FT³/YR	282.1
Divide FT³/yr by 27				TOTAL YD³/YR	17.4						TOTAL YD³/YR	10.4
Multiply YD³/yr by 1.3				**TOTAL TONS/YR**	22.7						**TOTAL TONS/YR**	13.6

Total Length 3570 3570

Total ft assessed	7140
Total TONS per year	36.2
Tons per ft per year	0.0051
Tons per 1000ft	5.1

North Carolina unpublished curve (Alan Walker, NRCS)

	V. Low	**Low**	**Low-Mod**	**Mod**	**Mod-High**	**High**	**V. High**	**Extreme**	**BEHI**
V. Low	0.008	0.02	0.03	0.035	0.07	0.1	0.2	0.8	
Low	0.02	0.034	0.055	0.09	0.15	0.18	0.18	0.44	
Low-Mod	0.03	0.051	0.078	0.135	0.2	0.24	0.24	0.77	
Mod	0.035	0.068	0.1	0.18	0.25	0.3	0.3	1.1	
Mod-High	0.07	0.1	0.15	0.27	0.3	0.4	0.4	1.8	
High	0.1	0.14	0.25	0.38	0.4	0.5	0.5	2.7	
V. High	0.2	0.28	0.4	0.78	0.8	0.8	0.8	6	
Extreme	0.8	0.52	0.6	1.6	1.5	1.5	1.5	10	
NBS									

BANCS Method Calcs

Appendix 2

Location: Hornpipe, MS2 Field Crew: K. VanStell, C. Manner Date: 1/8/2020

SEDIMENT LOADING ASSESSMENT SHEET

LEFT BANK							RIGHT BANK					
A	B	C	D	E	F		A	B	C	D	E	F
BEHI	NBS	STUDY BANK HEIGHT	FEET/YR (from curve)	DISTANCE (note station for detailed design needs)	TOTAL FT³/yr =(C×D×E)	STA	BEHI	NBS	STUDY BANK HEIGHT	FEET/YR (from curve)	DISTANCE (note station for detailed design needs)	TOTAL FT³/yr =(C×D×E)
Low-Mod	V. Low	3.1	0.03	365	33.9	1365	Low-Mod	V. Low	3.0	0.03	365	32.9
V. Low	V. Low	1.9	0.008	305	4.6	1670	V. Low	V. Low	2.1	0.008	305	5.1
Mod	V. Low	4.1	0.035	235	33.7	1905	Mod	V. Low	4.1	0.035	235	33.7
				TOTAL FT³/YR	72.3						TOTAL FT³/YR	71.7
Divide FT³/yr by 27				TOTAL YD³/YR	2.7						TOTAL YD³/YR	2.7
Multiply YD³/yr by 1.3				**TOTAL TONS/YR**	3.5						**TOTAL TONS/YR**	3.5

Total Length 905 905

Total ft assessed	1810
Total TONS per year	6.9
Tons per ft per year	0.0038
Tons per 1000ft	3.8

North Carolina unpublished curve (Alan Walker, NRCS)

	V. Low	Low	Low-Mod	Mod	Mod-High	High	V. High	Extreme	BEHI
V. Low	0.008	0.02	0.03	0.035	0.07	0.1	0.2	0.8	
Low	0.02	0.034	0.055	0.09	0.15	0.18	0.18	0.44	
Low-Mod	0.03	0.051	0.078	0.135	0.2	0.24	0.24	0.77	
Mod	0.035	0.068	0.1	0.18	0.25	0.3	0.3	1.1	
Mod-High	0.07	0.1	0.15	0.27	0.3	0.4	0.4	1.8	
High	0.1	0.14	0.25	0.38	0.4	0.5	0.5	2.7	
V. High	0.2	0.28	0.4	0.78	0.8	0.8	0.8	6	
Extreme	0.8	0.52	0.6	1.6	1.5	1.5	1.5	10	
NBS									

BANCS Method Calcs

Location: Hornpipe, MS3 | Field Crew: K. VanStell, C. Manner | Date: 1/8/2020

SEDIMENT LOADING ASSESSMENT SHEET

LEFT BANK							RIGHT BANK					
A	B	C	D	E	F		A	B	C	D	E	F
BEHI	**NBS**	**STUDY BANK HEIGHT**	**FEET/YR (from curve)**	**DISTANCE (note station for detailed design needs)**	**TOTAL FT³/yr =(C×D×E)**	**STA**	**BEHI**	**NBS**	**STUDY BANK HEIGHT**	**FEET/YR (from curve)**	**DISTANCE (note station for detailed design needs)**	**TOTAL FT³/yr =(C×D×E)**
Low-Mod	Low	4.9	0.055	270	72.8	1270	Low-Mod	Low	4.8	0.055	270	71.3
Low	V. Low	4.5	0.02	110	9.9	1380	Low	V. Low	4.7	0.02	110	10.3
Mod	Low	3.9	0.09	530	186.0	1910	Mod	Low	4.2	0.09	530	200.3
High	Mod	4.2	0.3	190	239.4	2100	Low-Mod	Low-Mod	4.1	0.078	190	60.8
V. High	Mod	3.4	0.3	60	61.2	2160	Low-Mod	Low	3.6	0.055	60	11.9
High	Mod	3.1	0.3	170	158.1	2330	V. High	Mod	3.3	0.3	170	168.3

		Left bank	Right bank
	TOTAL FT³/YR	727.4	522.9
Divide FT³/yr by 27	TOTAL YD³/YR	26.9	19.4
Multiply YD³/yr by 1.3	**TOTAL TONS/YR**	35.0	25.2
Total Length		1330	1330

North Carolina unpublished curve (Alan Walker, NRCS)

	V. Low	Low	Low-Mod	Mod	Mod-High	High	V. High	Extreme	BEHI
V. Low	0.008	0.02	0.03	0.035	0.07	0.1	0.2	0.8	
Low	0.02	0.034	0.055	0.09	0.15	0.18	0.18	0.44	
Low-Mod	0.03	0.051	0.078	0.135	0.2	0.24	0.24	0.77	
Mod	0.035	0.068	0.1	0.18	0.25	0.3	0.3	1.1	
Mod-High	0.07	0.1	0.15	0.27	0.3	0.4	0.4	1.8	
High	0.1	0.14	0.25	0.38	0.4	0.5	0.5	2.7	
V. High	0.2	0.28	0.4	0.78	0.8	0.8	0.8	6	
Extreme	0.8	0.52	0.6	1.6	1.5	1.5	1.5	10	
NBS									

Total ft assessed	2660
Total TONS per year	60.2
Tons per ft per year	0.0226
Tons per 1000ft	22.6

BANCS Method Calcs

Appendix 2

Location:	Hornpipe, UT1	Field Crew: K. VanStell, C. Manner	Date:	1/8/2020

SEDIMENT LOADING ASSESSMENT SHEET

LEFT BANK

A **BEHI**	B **NBS**	C **STUDY BANK HEIGHT**	D **FEET/YR (from curve)**	E **DISTANCE (note station for detailed design needs)**	F **TOTAL FT³/yr =(C×D×E)**	**STA**
Mod	Low	3.1	0.09	1110	309.7	2110
				TOTAL FT³/YR	309.7	
Divide FT³/yr by 27				TOTAL YD³/YR	11.5	
Multiply YD³/yr by 1.3				**TOTAL TONS/YR**	14.9	
Total Length				1110		

RIGHT BANK

A **BEHI**	B **NBS**	C **STUDY BANK HEIGHT**	D **FEET/YR (from curve)**	E **DISTANCE (note station for detailed design needs)**	F **TOTAL FT³/yr =(C×D×E)**	**STA**
Mod	Low	3.1	0.09	1110	309.7	2110
				TOTAL FT³/YR	309.7	
				TOTAL YD³/YR	11.5	
				TOTAL TONS/YR	14.9	
				1110		

North Carolina unpublished curve (Alan Walker, NRCS)

	V. Low	**Low**	**Low-Mod**	**Mod**	**Mod-High**	**High**	**V. High**	**Extreme**	**BEHI**
V. Low	0.008	0.02	0.03	0.035	0.07	0.1	0.2	0.8	
Low	0.02	0.034	0.055	0.09	0.15	0.18	0.18	0.44	
Low-Mod	0.03	0.051	0.078	0.135	0.2	0.24	0.24	0.77	
Mod	0.035	0.068	0.1	0.18	0.25	0.3	0.3	1.1	
Mod-High	0.07	0.1	0.15	0.27	0.3	0.4	0.4	1.8	
High	0.1	0.14	0.25	0.38	0.4	0.5	0.5	2.7	
V. High	0.2	0.28	0.4	0.78	0.8	0.8	0.8	6	
Extreme	0.8	0.52	0.6	1.6	1.5	1.5	1.5	10	
NBS									

Total ft assessed	2220
Total TONS per year	29.8
Tons per ft per year	0.0134
Tons per 1000ft	13.4

BANCS Method Calcs | Appendix 2

Location:	Hornpipe, UT2	Field Crew: K. VanStell, C. Manner	Date:	1/8/2020

SEDIMENT LOADING ASSESSMENT SHEET

LEFT BANK

A	B	C	D	E	F	
BEHI	**NBS**	**STUDY BANK HEIGHT**	**FEET/YR (from curve)**	**DISTANCE (note station for detailed design needs)**	**TOTAL FT³/yr =(C×D×E)**	**STA**
Mod	Low	4.0	0.09	960	345.6	1960
				TOTAL FT³/YR	345.6	
Divide FT³/yr by 27				TOTAL YD³/YR	12.8	
Multiply YD³/yr by 1.3				**TOTAL TONS/YR**	16.6	

Total Length 960

RIGHT BANK

A	B	C	D	E	F	
BEHI	**NBS**	**STUDY BANK HEIGHT**	**FEET/YR (from curve)**	**DISTANCE (note station for detailed design needs)**	**TOTAL FT³/yr =(C×D×E)**	**STA**
Mod	Low	3.5	0.09	960	302.4	1960
				TOTAL FT³/YR	302.4	
				TOTAL YD³/YR	11.2	
				TOTAL TONS/YR	14.6	

960

North Carolina unpublished curve (Alan Walker, NRCS)

	V. Low	**Low**	**Low-Mod**	**Mod**	**Mod-High**	**High**	**V. High**	**Extreme**	**BEHI**
V. Low	0.008	0.02	0.03	0.035	0.07	0.1	0.2	0.8	
Low	0.02	0.034	0.055	0.09	0.15	0.18	0.18	0.44	
Low-Mod	0.03	0.051	0.078	0.135	0.2	0.24	0.24	0.77	
Mod	0.035	0.068	0.1	0.18	0.25	0.3	0.3	1.1	
Mod-High	0.07	0.1	0.15	0.27	0.3	0.4	0.4	1.8	
High	0.1	0.14	0.25	0.38	0.4	0.5	0.5	2.7	
V. High	0.2	0.28	0.4	0.78	0.8	0.8	0.8	6	
Extreme	0.8	0.52	0.6	1.6	1.5	1.5	1.5	10	
NBS									

Total ft assessed	1920
Total TONS per year	31.2
Tons per ft per year	0.0163
Tons per 1000ft	16.3

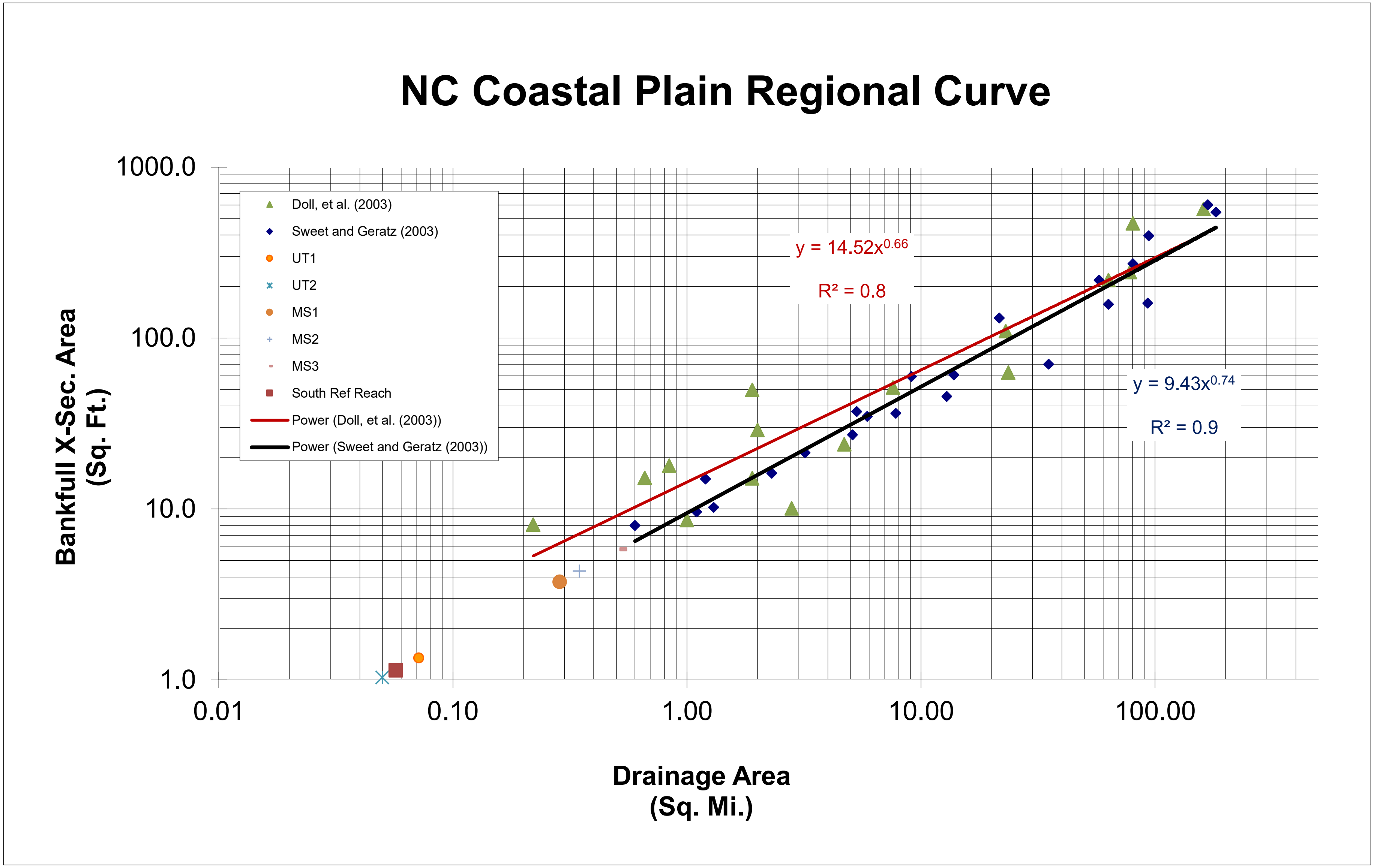
Total Load This is the summary of annual nutrient and sediment load for each subwatershed. This sheet is initially protected.

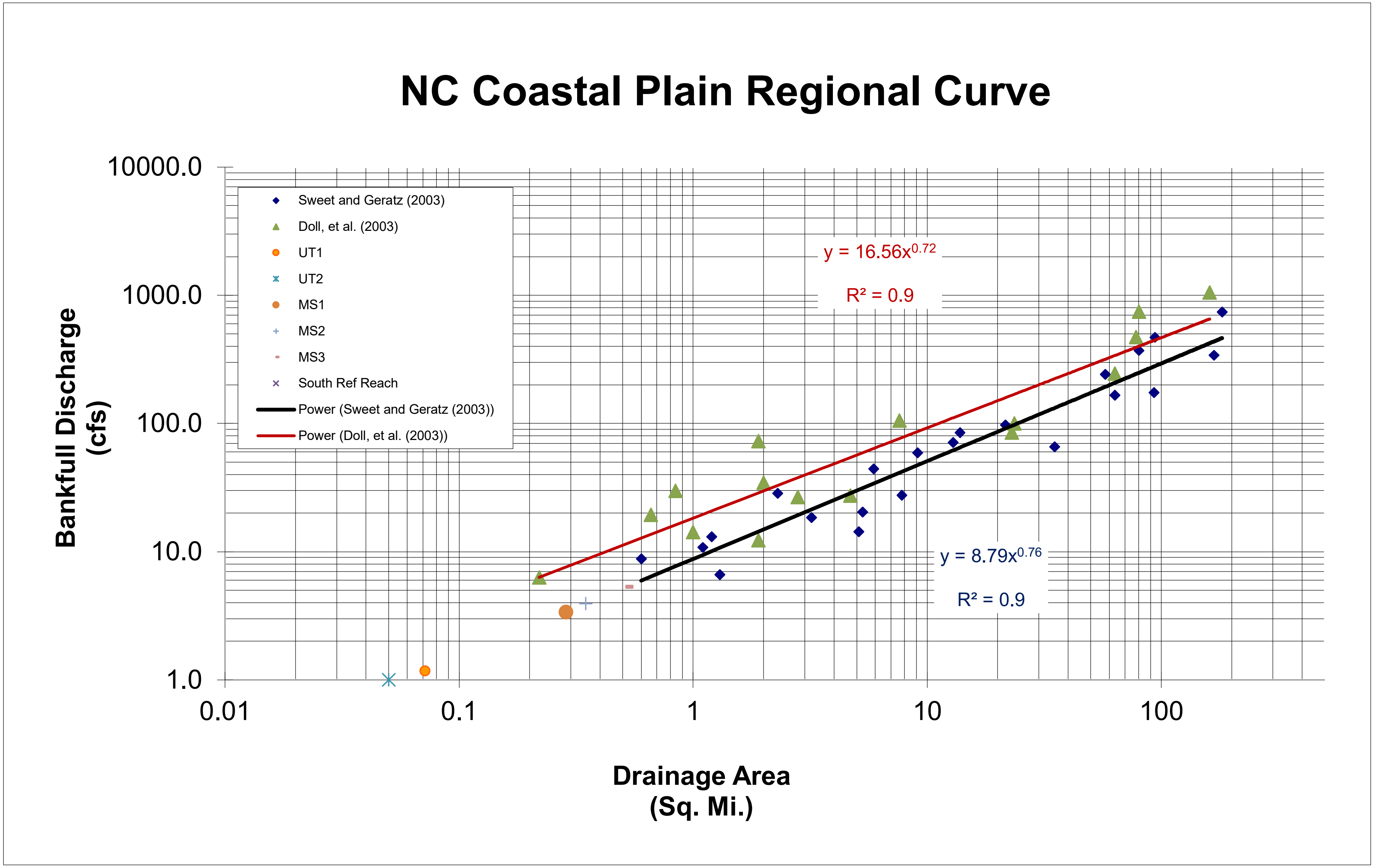
1. Total load by subwatershed(s)

Watershed	N Load (no BMP)	P Load (no BMP)	BOD Load (no BMP)	Sediment Load (no BMP)	E. coli Load (no BMP)	N Reduction	P Reduction	BOD Reduction	Sediment Reduction	E. coli Reduction	N Load (with BMP)	P Load (with BMP)	BOD (with BMP)	Sediment Load (with BMP)	E. coli Load (with BMP)	%N Reduction	%P Reduction	%BOD Reduction	%Sed Reduction	%E. coli Reduction
	lb/year	lb/year	lb/year	t/year	Billion MPN/ye	lb/year	lb/year	lb/year	t/year	Billion MPN/ye	lb/year	lb/year	lb/year	t/year	Billion MPN/ye	%	%	%	%	%
W1	2009.4	555.6	4148.0	319.2	0.0	743.0	204.0	763.3	120.8	0.0	1266.4	351.6	3384.7	198.4	0.0	37.0	36.7	18.4	37.8	0.0
Total	2009.4	555.6	4148.0	319.2	0.0	743.0	204.0	763.3	120.8	0.0	1266.4	351.6	3384.7	198.4	0.0	37.0	36.7	18.4	37.8	0.0

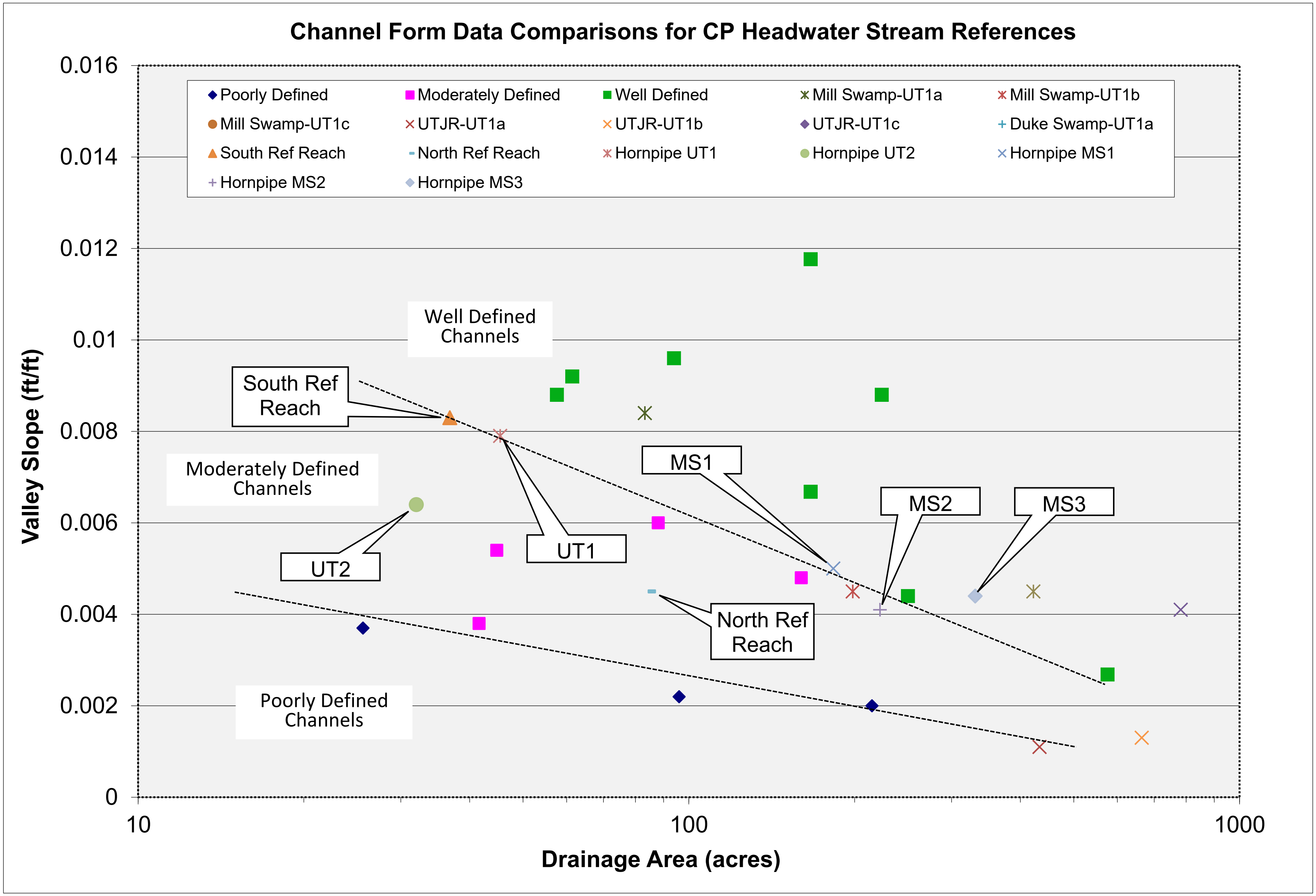
2. Total load by land uses (with BMP)

Sources	N Load (lb/yr)	P Load (lb/yr)	BOD Load (lb/yr)	Sediment Load (t/yr)	E. coli Load (Billion MPN/yr)
Urban	7.05	1.07	27.25	0.16	0.00
Cropland	1232.30	337.66	3288.73	196.89	0.00
Pastureland	0.00	0.00	0.00	0.00	0.00
Forest	24.83	12.01	60.33	1.09	0.00
Feedlots	0.00	0.00	0.00	0.00	0.00
User Defined	0.00	0.00	0.00	0.00	0.00
Septic	1.87	0.73	7.62	0.00	0.00
Gully	0.00	0.00	0.00	0.00	0.00
Streambank	0.40	0.15	0.80	0.30	0.00
Groundwater	0.00	0.00	0.00	0.00	0.00
Total	1266.44	351.63	3384.73	198.44	0.00


NC Coastal Plain Regional Curve
Bankfull X-Sec. Area
(Sq. Ft.)
1000.0
100.0
10.0
1.0
0.01
0.10
1.00
10.00
100.00
Drainage Area
(Sq. Mi.)
Doll, et al. (2003)
Sweet and Geratz (2003)
UT1
UT2
MS1
MS2
MS3
South Ref Reach
Power (Doll, et al. (2003))
Power (Sweet and Geratz (2003))
y = 14.52x0.66
R² = 0.8
y = 9.43x0.74
R² = 0.9



NC Coastal Plain Regional Curve
Bankfull Discharge (cfs)
Drainage Area (Sq. Mi.)
10000.0
1000.0
100.0
10.0
1.0
0.01
0.1
1
10
100
Sweet and Geratz (2003)
Doll, et al. (2003)
UT1
UT2
MS1
MS2
MS3
South Ref Reach
Power (Sweet and Geratz (2003))
Power (Doll, et al. (2003))
y = 16.56x^0.72
R² = 0.9
y = 8.79x^0.76
R² = 0.9



Channel Form Data Comparisons for CP Headwater Stream References
Valley Slope (ft/ft)
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
10
100
1000
Drainage Area (acres)
Poorly Defined
Moderately Defined
Well Defined
Mill Swamp-UT1a
Mill Swamp-UT1b
Mill Swamp-UT1c
UTJR-UT1a
UTJR-UT1b
UTJR-UT1c
Duke Swamp-UT1a
South Ref Reach
North Ref Reach
Hornpipe UT1
Hornpipe UT2
Hornpipe MS1
Hornpipe MS2
Hornpipe MS3
Well Defined Channels
South Ref Reach
Moderately Defined Channels
UT2
UT1
MS1
MS2
MS3
North Ref Reach
Poorly Defined Channels

****
----Lateral Effect Program Summary----
Application of Skaggs Method
Copyright 2006-2014. Brian D Phillips, R Wayne Skaggs, G M Chescheir
North Carolina State University Dept of Biological & Agricultural Engineering
Version: 2.8.1.0
Project Run Date and Time: 1/26/2020 12:08:37 PM
Output Filename: C:\LateralEffect\outputs\.txt
****
Project Information

Project : Hornpipe Branch Tribs
User: Kayne V.
Company / Agency: WLS
Department: -

Project Location: Lenoir County, NC

Project Coordinates: 35.134242°, -77.655045°

Soil ID: Johnston (JS)

Notes: MS tributary - existing conditions

Site Parameters

State: North_Carolina
County / Parish: Lenoir

Surface Storage: 2_inch_(5.0_cm)
Ditch Depth or Depth to Water Surface: 3.0 ft
Depth to Restrictive Layer: 6.7 ft
Drainable Porosity: 0.04

Hydroperiod: 14 days

User defined T25 or Default T25: DEFAULT
T25 value: 5.6 days

User Conductivity or Soil Survey Conductivity: SOIL SURVEY
Weighted Hydraulic Conductivity: 9.5935 in/hr

Hydraulic Conductivity Data by Layer for Soil: JS__Johnston__drained
Weighted Hydraulic Conductivity Calculated Using: Average K Values

Bottom Depth in Low K in/hr High K in/hr Average K in/hr

Layer 1	30.00	1.98	5.95	3.968496
Layer 2	34.00	5.95	19.98	12.968478
Layer 3	80.00	5.95	19.98	12.968478

Lateral Effect: 174.7 ft

****
----Lateral Effect Program Summary----
Application of Skaggs Method

North Carolina State University Dept of Biological & Agricultural Engineering
Version: 2.8.1.0
Project Run Date and Time: 1/26/2020 12:20:01 PM
Output Filename: C:\LateralEffect\outputs\.txt

****

Project Information

Project : Hornpipe Branch Tribs
User: Kayne V.
Company / Agency: WLS
Department: -

Project Location: Lenoir County, NC
Project Coordinates: 35.131666°, -77.653056°

Soil ID: Pocalla (Po)

Notes: UT1 - existing

Site Parameters

State: North_Carolina
County / Parish: Lenoir

Surface Storage: 2_inch_(5.0_cm)
Ditch Depth or Depth to Water Surface: 3.9 ft
Depth to Restrictive Layer: 6.67 ft
Drainable Porosity: 0.04

Hydroperiod: 14 days

User defined T25 or Default T25: DEFAULT
T25 value: 5.78 days

User Conductivity or Soil Survey Conductivity: SOIL SURVEY
Weighted Hydraulic Conductivity: 6.5365 in/hr

Hydraulic Conductivity Data by Layer for Soil: Po__Pocalla
Weighted Hydraulic Conductivity Calculated Using: Average K Values

Bottom Depth in Low K in/hr High K in/hr Average K in/hr

Layer 1	8.00	5.95	19.98	12.968478
Layer 2	23.00	5.95	19.98	12.968478
Layer 3	36.00	1.98	5.95	3.968496
Layer 4	46.00	5.95	19.98	12.968478
Layer 5	80.00	0.57	1.98	1.275588
Layer 6	0.00	0.00	0.00	0.00
Layer 7	0.00	0.00	0.00	0.00
Layer 8	0.00	0.00	0.00	0.00

Lateral Effect: 161.9 ft

****
----Lateral Effect Program Summary----
Application of Skaggs Method

North Carolina State University Dept of Biological & Agricultural Engineering
Version: 2.8.1.0
Project Run Date and Time: 1/26/2020 12:30:03 PM
Output Filename: C:\LateralEffect\outputs\.txt

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Project Information

Project : Hornpipe Branch Tribs
User: Kayne V.
Company / Agency: WLS
Department: -

Project Location: Lenoir County, NC
Project Coordinates: 35.133028Â°, -77.652956Â°

Soil ID: Johnston (JS)

Notes: UT2 - existing

Site Parameters

State: North_Carolina
County / Parish: Lenoir

Surface Storage: 2_inch_(5.0_cm)
Ditch Depth or Depth to Water Surface: 3.0 ft
Depth to Restrictive Layer: 6.67 ft
Drainable Porosity: 0.04

Hydroperiod: 14 days

User defined T25 or Default T25: DEFAULT
T25 value: 5.6 days

User Conductivity or Soil Survey Conductivity: SOIL SURVEY
Weighted Hydraulic Conductivity: 9.5935 in/hr

Hydraulic Conductivity Data by Layer for Soil: JS__Johnston__drained
Weighted Hydraulic Conductivity Calculated Using: Average K Values

Bottom Depth in   Low K in/hr   High K in/hr   Average K in/hr

Layer 1	30.00	1.98	5.95	3.968496
Layer 2	34.00	5.95	19.98	12.968478
Layer 3	80.00	5.95	19.98	12.968478

Lateral Effect: 174.7 ft

****
----Lateral Effect Program Summary----
Application of Skaggs Method

North Carolina State University Dept of Biological & Agricultural Engineering
Version: 2.8.1.0
Project Run Date and Time: 1/26/2020 12:36:49 PM
Output Filename: C:\LateralEffect\outputs\Lateral_Effect_Summary.txt

****

Project Information

Project : Hornpipe Branch Tribs
User: Kayne V.
Company / Agency: WLS
Department: -

Project Location: Lenoir County, NC
Project Coordinates: 35.134242°, -77.65504°

Soil ID: Johnston (JS)

Notes: MS - prop channel depth ~1ft

Site Parameters

State: North_Carolina
County / Parish: Lenoir

Surface Storage: 2_inch_(5.0_cm)
Ditch Depth or Depth to Water Surface: 1 ft
Depth to Restrictive Layer: 6.67 ft
Drainable Porosity: 0.04

Hydroperiod: 14 days

User defined T25 or Default T25: DEFAULT
T25 value: 5.7 days

User Conductivity or Soil Survey Conductivity: SOIL SURVEY
Weighted Hydraulic Conductivity: 9.5935 in/hr

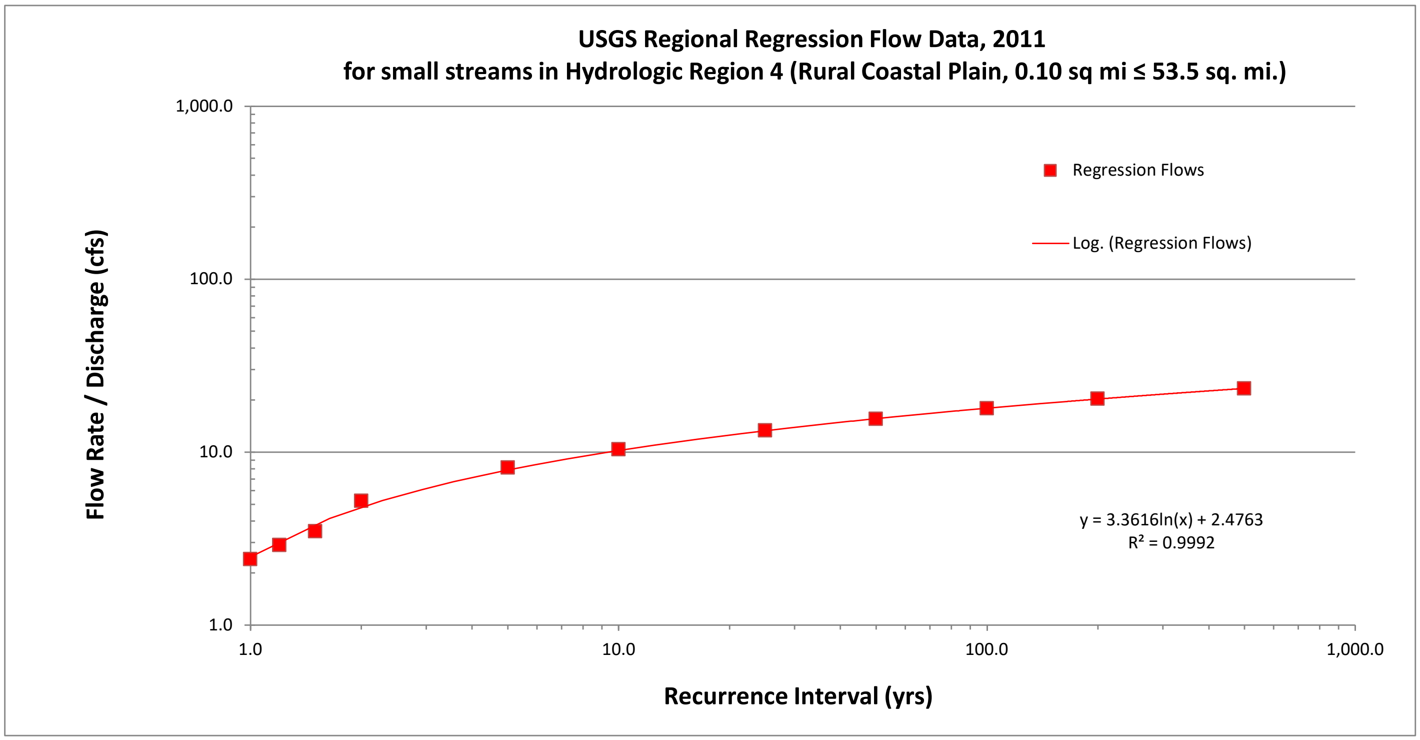
Hydraulic Conductivity Data by Layer for Soil: JS__Johnston__drained
Weighted Hydraulic Conductivity Calculated Using: Average K Values

	Bottom Depth in	Low K in/hr	High K in/hr	Average K in/hr
Layer 1	30.00	1.98	5.95	3.968496
Layer 2	34.00	5.95	19.98	12.968478
Layer 3	80.00	5.95	19.98	12.968478

Lateral Effect: 39.5 ft

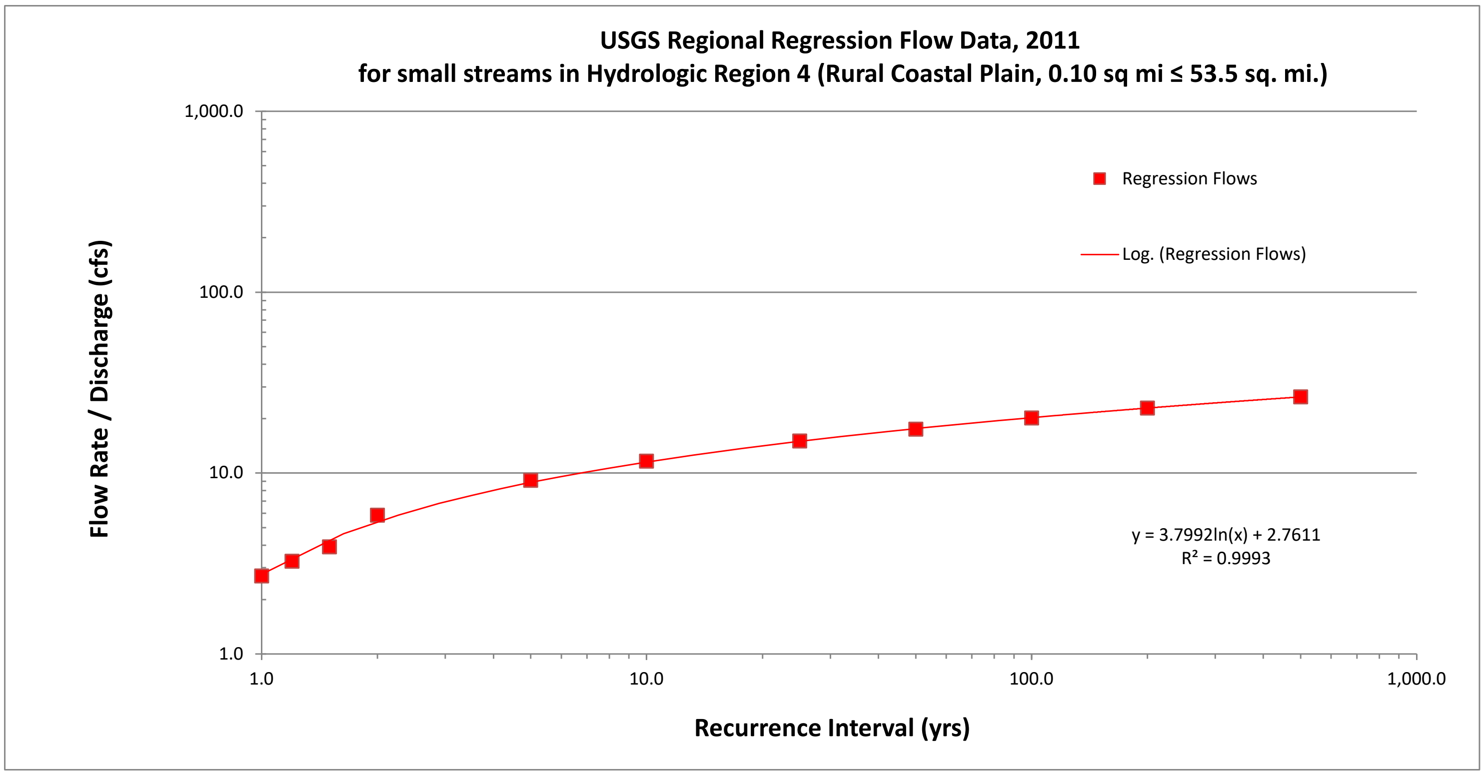
Site Description	DA (sq. mi.)
Hornpipe (MS1)	0.286

T-yr recurrence interval	AEP-annual exceedance probability	P-percent annual exceedance probability	Q-discharge estimate (cfs)	Notes
1	1.00	100.0%	2.4	extrapolated
1.2	0.83	83.3%	2.9	extrapolated
1.5	0.67	66.7%	3.5	extrapolated Qgs = 0.66*Q2
2	0.5	50.0%	5.2	USGS regional regression, 2011 (small streams, HR4, 0.10≤53.5 sq. mi.)
5	0.2	20.0%	8.1	USGS regional regression, 2011 (small streams, HR4, 0.10≤53.5 sq. mi.)
10	0.1	10.0%	10.3	USGS regional regression, 2011 (small streams, HR4, 0.10≤53.5 sq. mi.)
25	0.04	4.0%	13.3	USGS regional regression, 2011 (small streams, HR4, 0.10≤53.5 sq. mi.)
50	0.02	2.0%	15.6	USGS regional regression, 2011 (small streams, HR4, 0.10≤53.5 sq. mi.)
100	0.01	1.0%	17.9	USGS regional regression, 2011 (small streams, HR4, 0.10≤53.5 sq. mi.)
200	0.005	0.5%	20.3	USGS regional regression, 2011 (small streams, HR4, 0.10≤53.5 sq. mi.)
500	0.002	0.2%	23.3	USGS regional regression, 2011 (small streams, HR4, 0.10≤53.5 sq. mi.)



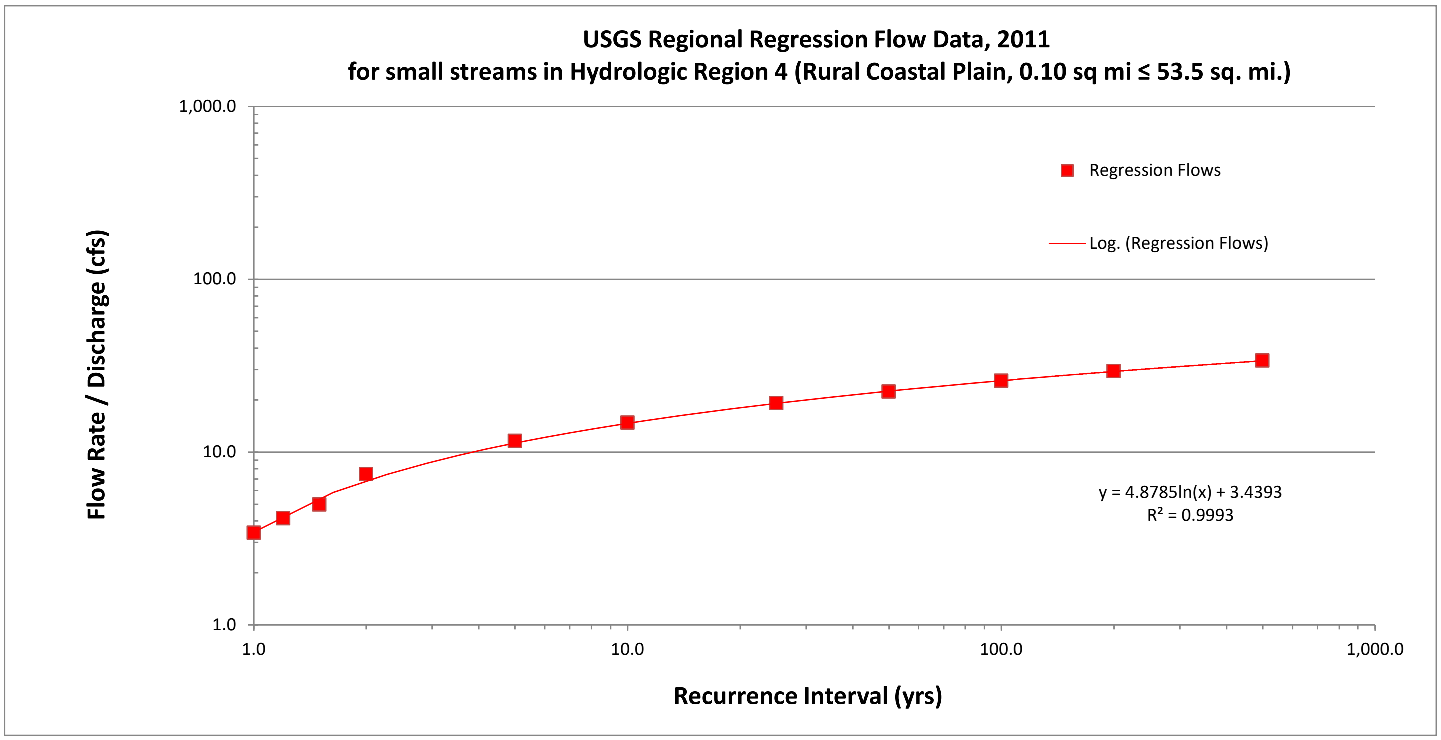
Site Description	DA (sq. mi.)
Hornpipe (MS2)	0.347

T-yr recurrence interval	AEP-annual exceedance probability	P-percent annual exceedance probability	Q-discharge estimate (cfs)	Notes
1	1.00	100.0%	2.7	extrapolated
1.2	0.83	83.3%	3.3	extrapolated
1.5	0.67	66.7%	3.9	extrapolated Qgs = 0.66*Q2
2	0.5	50.0%	5.9	USGS regional regression, 2011 (small streams, HR4, 0.10≤53.5 sq. mi.)
5	0.2	20.0%	9.1	USGS regional regression, 2011 (small streams, HR4, 0.10≤53.5 sq. mi.)
10	0.1	10.0%	11.6	USGS regional regression, 2011 (small streams, HR4, 0.10≤53.5 sq. mi.)
25	0.04	4.0%	15.0	USGS regional regression, 2011 (small streams, HR4, 0.10≤53.5 sq. mi.)
50	0.02	2.0%	17.5	USGS regional regression, 2011 (small streams, HR4, 0.10≤53.5 sq. mi.)
100	0.01	1.0%	20.2	USGS regional regression, 2011 (small streams, HR4, 0.10≤53.5 sq. mi.)
200	0.005	0.5%	22.9	USGS regional regression, 2011 (small streams, HR4, 0.10≤53.5 sq. mi.)
500	0.002	0.2%	26.4	USGS regional regression, 2011 (small streams, HR4, 0.10≤53.5 sq. mi.)



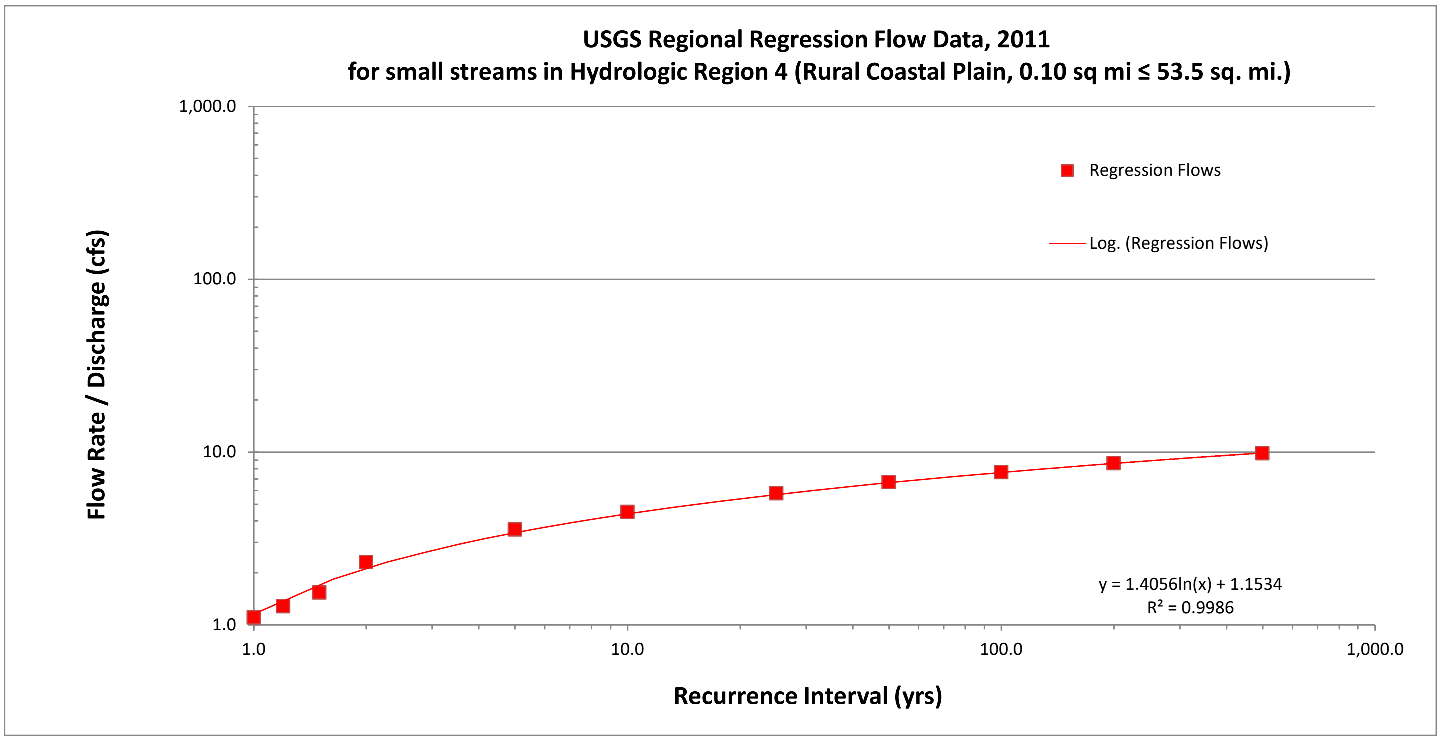
Site Description	DA (sq. mi.)
Hornpipe (MS3)	0.517

T-yr recurrence interval	AEP-annual exceedance probability	P-percent annual exceedance probability	Q-discharge estimate (cfs)	Notes
1	1.00	100.0%	3.4	extrapolated
1.2	0.83	83.3%	4.1	extrapolated
1.5	0.67	66.7%	4.9	extrapolated Qgs = 0.66*Q2
2	0.5	50.0%	7.4	USGS regional regression, 2011 (small streams, HR4, 0.10≤53.5 sq. mi.)
5	0.2	20.0%	11.6	USGS regional regression, 2011 (small streams, HR4, 0.10≤53.5 sq. mi.)
10	0.1	10.0%	14.8	USGS regional regression, 2011 (small streams, HR4, 0.10≤53.5 sq. mi.)
25	0.04	4.0%	19.1	USGS regional regression, 2011 (small streams, HR4, 0.10≤53.5 sq. mi.)
50	0.02	2.0%	22.3	USGS regional regression, 2011 (small streams, HR4, 0.10≤53.5 sq. mi.)
100	0.01	1.0%	25.8	USGS regional regression, 2011 (small streams, HR4, 0.10≤53.5 sq. mi.)
200	0.005	0.5%	29.3	USGS regional regression, 2011 (small streams, HR4, 0.10≤53.5 sq. mi.)
500	0.002	0.2%	33.8	USGS regional regression, 2011 (small streams, HR4, 0.10≤53.5 sq. mi.)



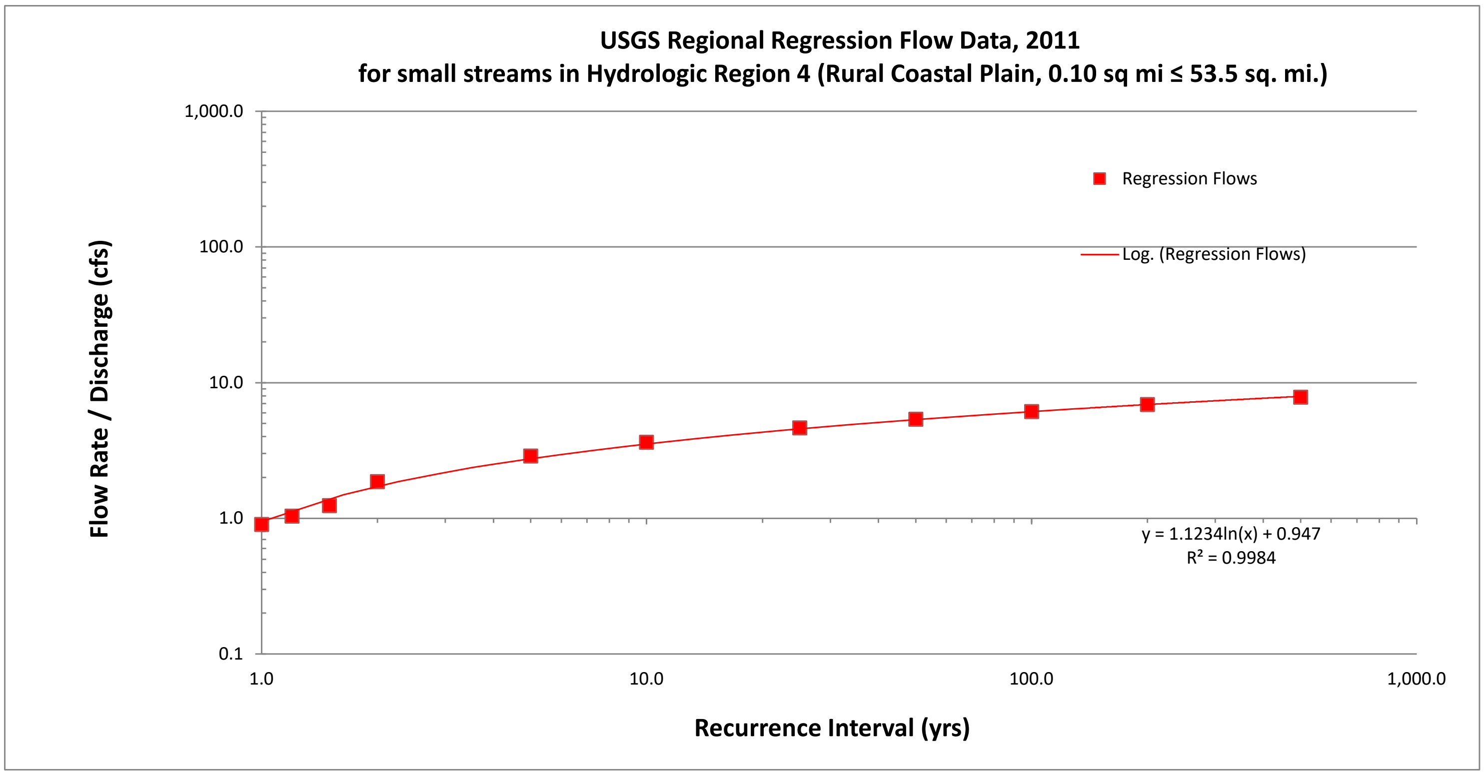
Site Description	DA (sq. mi.)
Hornpipe (UT1)	0.071

T-yr recurrence interval	AEP-annual exceedance probability	P-percent annual exceedance probability	Q-discharge estimate (cfs)	Notes
1	1.00	100.0%	1.1	extrapolated
1.2	0.83	83.3%	1.3	extrapolated
1.5	0.67	66.7%	1.5	extrapolated Qgs = 0.66*Q2
2	0.5	50.0%	2.3	USGS regional regression, 2011 (small streams, HR4, 0.10≤53.5 sq. mi.)
5	0.2	20.0%	3.6	USGS regional regression, 2011 (small streams, HR4, 0.10≤53.5 sq. mi.)
10	0.1	10.0%	4.5	USGS regional regression, 2011 (small streams, HR4, 0.10≤53.5 sq. mi.)
25	0.04	4.0%	5.8	USGS regional regression, 2011 (small streams, HR4, 0.10≤53.5 sq. mi.)
50	0.02	2.0%	6.7	USGS regional regression, 2011 (small streams, HR4, 0.10≤53.5 sq. mi.)
100	0.01	1.0%	7.6	USGS regional regression, 2011 (small streams, HR4, 0.10≤53.5 sq. mi.)
200	0.005	0.5%	8.6	USGS regional regression, 2011 (small streams, HR4, 0.10≤53.5 sq. mi.)
500	0.002	0.2%	9.8	USGS regional regression, 2011 (small streams, HR4, 0.10≤53.5 sq. mi.)



Site Description	DA (sq. mi.)
Hornpipe (UT2)	0.050

T-yr recurrence interval	AEP-annual exceedance probability	P-percent annual exceedance probability	Q-discharge estimate (cfs)	Notes
1	1.00	100.0%	0.9	extrapolated
1.2	0.83	83.3%	1.0	extrapolated
1.5	0.67	66.7%	1.2	extrapolated Qgs = 0.66*Q2
2	0.5	50.0%	1.9	USGS regional regression, 2011 (small streams, HR4, 0.10≤53.5 sq. mi.)
5	0.2	20.0%	2.9	USGS regional regression, 2011 (small streams, HR4, 0.10≤53.5 sq. mi.)
10	0.1	10.0%	3.6	USGS regional regression, 2011 (small streams, HR4, 0.10≤53.5 sq. mi.)
25	0.04	4.0%	4.6	USGS regional regression, 2011 (small streams, HR4, 0.10≤53.5 sq. mi.)
50	0.02	2.0%	5.4	USGS regional regression, 2011 (small streams, HR4, 0.10≤53.5 sq. mi.)
100	0.01	1.0%	6.1	USGS regional regression, 2011 (small streams, HR4, 0.10≤53.5 sq. mi.)
200	0.005	0.5%	6.9	USGS regional regression, 2011 (small streams, HR4, 0.10≤53.5 sq. mi.)
500	0.002	0.2%	7.8	USGS regional regression, 2011 (small streams, HR4, 0.10≤53.5 sq. mi.)



Catchment Assessment Form

Rater(s): K. VanStell

Date: 1/24/20

Overall Catchment Condition	**F**
Restoration Potential	**Level 3 - Geomorphology**

Purpose: This form is used to determine the project's restoration potential.

CATCHMENT ASSESSMENT

	Categories	Description of Catchment Condition: Poor	Fair	Good	Rating (P/F/G)
1	Concentrated Flow (Hydrology)	Potential for concentrated flow/impairments immediately upstream of the project and no treatments are in place	Some potential for concentrated flow/impairments to reach restoration site, however, measures are in place to protect resources	No potential for concentrated flow/impairments from adjacent land use	F
2	Impervious cover (Hydrology)	Greater than 25%	Between 10% and 25%	Less than 10%	G
3	Land Use Change (Hydrology)	Rapidly urbanizing/urban	Single family homes/suburban	Rural communities/slow growth or primarily forested	G
4	Distance to Roads (Hydrology)	Roads located in or adjacent to project reach and/or major roads proposed in 10 year DOT plans	No roads in or adjacent to project reach. No more than one major road proposed in 10 year DOT plans.	No roads in or adjacent to project reach. No proposed roads in 10 year DOT plans.	G
5	Percent Forested (Hydrology)	<= 20%	>20% and <70%	>=70%	P
6	Riparian Vegetation (Geomorphology)	<50% of contributing stream length has > 25 ft corridor width	50-80% of contributing stream length has > 25 ft corridor width	>80% of contributing stream length has > 25 ft corridor width	P
7	Sediment Supply (Geomorphology)	High sediment supply from upstream bank erosion and surface runoff	Moderate sediment supply from upstream bank erosion and surface runoff	Low sediment supply. Upstream bank erosion and surface runoff is minimal	G
8	Located on or downstream of a 303(d) listed stream TMDL list (Physicochemical)	On, upstream, or downstream of 303(d) and no TMDL/WS Mgmt plan to address deficiencies	On, upstream, or downstream of 303(d) and TMDL/WS Mgmt plan addressing deficiencies	Not on 303(d) list	G
9	Agricultural Land Use (Physicochemical)	Livestock access to stream and/or intensive cropland immediately upstream of project reach.	Livestock access to stream and/or intensive cropland upstream of project reach. A sufficient reach of stream is between Ag. land use and project reach.	There is little to no agricultural land uses or the livestock or cropland is far enough away from project reach to cause no impact to water quality or biology.	P
10	NPDES Permits (Physicochemical)	Many NPDES permits within catchment or some within one mile of project reach	A few NPDES permits within catchment and none within one mile of project reach	No NPDES permits within catchment and none within one mile of project reach	G
11	Specific Conductance (uS/cm at 25oC) (Physicochemical)	Piedmont = >229; Blue Ridge = >66	Piedmont = 78-229; Blue Ridge = 41-66	Piedmont = <78; Blue Ridge = <41	N/A
12	Watershed impoundments (Biology)	Impoundment(s) located within 1 mile upstream or downstream of project area and/or has a negative effect on project area and fish passage	No impoundment within 1 mile upstream or downstream of project area OR impoundment does not adversely affect project area but a blockage could exist outside of 1 mile and impact fish passage	No impoundment upstream or downstream of project area OR impoundment provides beneficial effect on project area and allows for fish passage	G
13	Organism Recruitment (Biology)	Channel immediately upstream or downstream of project reach is concrete, piped, or hardened.	Channel immediately upstream or downstream of project reach has native bed and bank material, but is impaired.	Channel immediately upstream or downstream of project reach has native bed and bank material.	P
14	Percent of Catchment being Enhanced or Restored	Less than 40% of the total catchment area is draining to the project reach.	40 to 60% of the total catchment area is draining to the project reach.	Greater than 60% of the total catchment area is draining to the project reach.	G
15	Other				

Site Information and Performance Standard Stratification	
Project Name:	Hornpipe Branch Tribs
Reach ID:	MS1
Restoration Potential:	Level 3 - Geomorphology
Existing Stream Type:	G
Proposed Stream Type:	C
Region:	Coastal Plain
Drainage Area (sqmi):	0.286
Proposed Bed Material:	Sand
Existing Stream Length (ft)	1449
Proposed Stream Length (ft):	1449
Stream Slope (%):	0.06
Flow Type:	Perennial
River Basin:	Neuse
Stream Temperature:	Warmwater
Data Collection Season:	Summer
Valley Type:	Unconfined Alluvial

Notes
1. Users input values that are highlighted based on restoration potential
2. Users select values from a pull-down menu
3. Leave values blank for field values that were not measured

FUNCTIONAL CHANGE SUMMARY	
Exisiting Condition Score (ECS)	0.14
Proposed Condition Score (PCS)	0.46
Change in Functional Condition (PCS - ECS)	0.32
Percent Condition Change	229%
Existing Stream Length (ft)	1449
Proposed Stream Length (ft)	1449
Additional Stream Length (ft)	0
Existing Functional Foot Score (FFS)	203
Proposed Functional Foot Score (FFS)	667
Proposed FFS - Existing FFS	464
Functional Change (%)	229%

BMP FUNCTIONAL CHANGE SUMMARY	
Existing BMP Functional Feet Score (FFS)	1571
Proposed BMP Functional Feet Score (FFS)	1571
Proposed BMP FFS - Existing BMP FFS	0
Functional Change (%)	0%

FUNCTIONAL FEET (FF) SUMMARY	
Existing Stream FFS + Existing BMP FFS	1774
Proposed Stream FFS + Proposed BMP FFS	2238
Total Proposed FFS - Total Existing FFS	464
Functional Change (%)	26%

FUNCTION BASED PARAMETERS SUMMARY

Functional Category	Function-Based Parameters	Existing Parameter	Proposed Parameter
Hydrology	Catchment Hydrology	0.23	0.56
	Reach Runoff	0.43	0.85
Hydraulics	Floodplain Connectivity	0.20	0.89
Geomorphology	Large Woody Debris	0.00	0.79
	Lateral Stability	0.72	1.00
	Riparian Vegetation	0.00	0.71
	Bed Material		
	Bed Form Diversity	0.20	1.00
	Plan Form	0.00	0.00
Physicochemical	Temperature		
	Bacteria		
	Organic Matter		
	Nitrogen		
	Phosphorus		
Biology	Macros		
	Fish		

FUNCTIONAL CATEGORY REPORT CARD

Functional Category	ECS	PCS	Functional Change
Hydrology	0.33	0.71	0.38
Hydraulics	0.20	0.89	0.69
Geomorphology	0.18	0.70	0.52
Physicochemical			
Biology			

EXISTING CONDITION ASSESSMENT

Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Parameter (Roll Up Scoring)	Category	Category	Overall	Overall
Hydrology	Catchment Hydrology	Curve Number	72	0.23	0.23	0.33	Functioning At Risk	0.14	Not Functioning
	Reach Runoff	Curve Number	72	0.23	0.43				
		Concentrated Flow Points	2	0.5					
		Soil Compaction	12	0.55					
Hydraulics	Floodplain Connectivity	Bank Height Ratio	2.6	0	0.20	0.20	Not Functioning		
		Entrenchment Ratio	2.1	0.4					
Geomorphology	Large Woody Debris	LWD Index			0.00	0.18	Not Functioning		
		# Pieces	0	0					
	Lateral Stability	Erosion Rate (ft/yr)			0.72				
		Dominant BEHI/NBS	L/L	1					
		Percent Streambank Erosion (%)	15	0.44					
	Riparian Vegetation	Left Canopy Coverage (%)	0	0	0.00				
		Right Canopy Coverage (%)	0	0					
		Left Buffer Width (ft)	0	0					
		Right Buffer Width (ft)	0	0					
		Left Basal Area (sq.ft/acre)							
		Right Basal Area (sq.ft/acre)							
		Left Stem Density (stems/acre)	0	0					
		Right Stem Density (stems/acre)	0	0					
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value)							
	Bed Form Diversity	Pool Spacing Ratio	7	0.3	0.20				
		Pool Depth Ratio	1	0					
		Percent Riffle	80	0.3					
		Aggradation Ratio							
	Plan Form	Sinuosity	1.01	0	0.00				
Physicochemical	Temperature	Summer Daily Maximum (°F)							
	Bacteria	Fecal Coliform (Cfu/100 ml)							
	Organic Carbon	Leaf Litter Processing Rate							
		Percent Shredders							
	Nitrogen	Total Nitrogen (mg/L)							
	Phosphorus	Total Phosphorus (mg/L)							
Biology	Macros	Biotic Index							
		EPT Taxa Present							
	Fish	North Carolina Index of Biotic Integrity							

PROPOSED CONDITION ASSESSMENT

Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Parameter (Roll Up Scoring)	Category	Category	Overall	Overall
Hydrology	Catchment Hydrology	Curve Number	61	0.56	0.56	0.71	Functioning	0.46	Functioning At Risk
	Reach Runoff	Curve Number	61	0.56	0.85				
		Concentrated Flow Points	0	1					
		Soil Compaction	36	1.00					
Hydraulics	Floodplain Connectivity	Bank Height Ratio	1	1	0.89	0.89	Functioning		
		Entrenchment Ratio	3	0.77					
Geomorphology	Large Woody Debris	LWD Index			0.79	0.70	Functioning		
		# Pieces	20	0.79					
	Lateral Stability	Erosion Rate (ft/yr)			1.00				
		Dominant BEHI/NBS	L/L	1					
		Percent Streambank Erosion (%)	5	1					
	Riparian Vegetation	Left Canopy Coverage (%)	100	1	0.71				
		Right Canopy Coverage (%)	100	1					
		Left Buffer Width (ft)	50	0.72					
		Right Buffer Width (ft)	50	0.72					
		Left Basal Area (sq.ft/acre)							
		Right Basal Area (sq.ft/acre)							
		Left Stem Density (stems/acre)	210	0.4					
		Right Stem Density (stems/acre)	210	0.4					
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value)							
	Bed Form Diversity	Pool Spacing Ratio			1.00				
		Pool Depth Ratio	1.3	1					
		Percent Riffle	70	1					
		Aggradation Ratio							
	Plan Form	Sinuosity	1.05	0	0.00				
Physicochemical	Temperature	Summer Daily Maximum (°F)							
	Bacteria	Fecal Coliform (Cfu/100 ml)							
	Organic Carbon	Leaf Litter Processing Rate							
		Percent Shredders							
	Nitrogen	Total Nitrogen (mg/L)							
	Phosphorus	Total Phosphorus (mg/L)							
Biology	Macros	Biotic Index							
		EPT Taxa Present							
	Fish	North Carolina Index of Biotic Integrity							

Site Information and Performance Standard Stratification	
Project Name:	Hornpipe Branch Tribs
Reach ID:	MS2
Restoration Potential:	Level 3 - Geomorphology
Existing Stream Type:	G
Proposed Stream Type:	C
Region:	Coastal Plain
Drainage Area (sqmi):	0.347
Proposed Bed Material:	Sand
Existing Stream Length (ft)	921
Proposed Stream Length (ft):	973
Stream Slope (%):	0.04
Flow Type:	Perennial
River Basin:	Neuse
Stream Temperature:	Warmwater
Data Collection Season:	Summer
Valley Type:	Unconfined Alluvial

Notes
1. Users input values that are highlighted based on restoration potential
2. Users select values from a pull-down menu
3. Leave values blank for field values that were not measured

FUNCTIONAL CHANGE SUMMARY	
Exisiting Condition Score (ECS)	0.15
Proposed Condition Score (PCS)	0.47
Change in Functional Condition (PCS - ECS)	0.32
Percent Condition Change	213%
Existing Stream Length (ft)	921
Proposed Stream Length (ft)	973
Additional Stream Length (ft)	52
Existing Functional Foot Score (FFS)	138
Proposed Functional Foot Score (FFS)	457
Proposed FFS - Existing FFS	319
Functional Change (%)	231%

BMP FUNCTIONAL CHANGE SUMMARY	
Existing BMP Functional Feet Score (FFS)	1044
Proposed BMP Functional Feet Score (FFS)	1044
Proposed BMP FFS - Existing BMP FFS	0
Functional Change (%)	0%

FUNCTIONAL FEET (FF) SUMMARY	
Existing Stream FFS + Existing BMP FFS	1182
Proposed Stream FFS + Proposed BMP FFS	1501
Total Proposed FFS - Total Existing FFS	319
Functional Change (%)	27%

FUNCTION BASED PARAMETERS SUMMARY

Functional Category	Function-Based Parameters	Existing Parameter	Proposed Parameter
Hydrology	Catchment Hydrology	0.23	0.56
	Reach Runoff	0.49	0.85
Hydraulics	Floodplain Connectivity	0.15	0.89
Geomorphology	Large Woody Debris	0.02	1.00
	Lateral Stability	0.82	1.00
	Riparian Vegetation	0.00	0.72
	Bed Material		
	Bed Form Diversity	0.36	1.00
	Plan Form	0.00	0.00
Physicochemical	Temperature		
	Bacteria		
	Organic Matter		
	Nitrogen		
	Phosphorus		
Biology	Macros		
	Fish		

FUNCTIONAL CATEGORY REPORT CARD

Functional Category	ECS	PCS	Functional Change
Hydrology	0.36	0.71	0.35
Hydraulics	0.15	0.89	0.74
Geomorphology	0.24	0.74	0.50
Physicochemical			
Biology			

EXISTING CONDITION ASSESSMENT					Roll Up Scoring				
Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Parameter	Category	Category	Overall	Overall
Hydrology	Catchment Hydrology	Curve Number	72	0.23	0.23	0.36	Functioning At Risk	0.15	Not Functioning
	Reach Runoff	Curve Number	72	0.23	0.49				
		Concentrated Flow Points	1	0.69					
		Soil Compaction	12	0.55					
Hydraulics	Floodplain Connectivity	Bank Height Ratio	2.2	0	0.15	0.15	Not Functioning		
		Entrenchment Ratio	2	0.3					
Geomorphology	Large Woody Debris	LWD Index			0.02	0.24	Not Functioning		
		# Pieces	3	0.02					
	Lateral Stability	Erosion Rate (ft/yr)			0.82				
		Dominant BEHI/NBS	L/L	1					
		Percent Streambank Erosion (%)	10	0.64					
	Riparian Vegetation	Left Canopy Coverage (%)	0	0	0.00				
		Right Canopy Coverage (%)	0	0					
		Left Buffer Width (ft)	0	0					
		Right Buffer Width (ft)	0	0					
		Left Basal Area (sq.ft/acre)							
		Right Basal Area (sq.ft/acre)							
		Left Stem Density (stems/acre)	0	0					
		Right Stem Density (stems/acre)	0	0					
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value							
	Bed Form Diversity	Pool Spacing Ratio	6	0.77	0.36				
		Pool Depth Ratio	1	0					
		Percent Riffle	80	0.3					
		Aggradation Ratio							
	Plan Form	Sinuosity	1.02	0	0.00				
Physicochemical	Temperature	Summer Daily Maximum (°F)							
	Bacteria	Fecal Coliform (Cfu/100 ml)							
	Organic Carbon	Leaf Litter Processing Rate							
		Percent Shredders							
	Nitrogen	Total Nitrogen (mg/L)							
	Phosphorus	Total Phosphorus (mg/L)							
Biology	Macros	Biotic Index							
		EPT Taxa Present							
	Fish	North Carolina Index of Biotic Integrity							

PROPOSED CONDITION ASSESSMENT					Roll Up Scoring				
Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Parameter	Category	Category	Overall	Overall
Hydrology	Catchment Hydrology	Curve Number	61	0.56	0.56	0.71	Functioning	0.47	Functioning At Risk
	Reach Runoff	Curve Number	61	0.56	0.85				
		Concentrated Flow Points	0	1					
		Soil Compaction	30	1.00					
Hydraulics	Floodplain Connectivity	Bank Height Ratio	1	1	0.89	0.89	Functioning		
		Entrenchment Ratio	3	0.77					
Geomorphology	Large Woody Debris	LWD Index			1.00	0.74	Functioning		
		# Pieces	50	1					
	Lateral Stability	Erosion Rate (ft/yr)			1.00				
		Dominant BEHI/NBS	L/L	1					
		Percent Streambank Erosion (%)	5	1					
	Riparian Vegetation	Left Canopy Coverage (%)	100	1	0.72				
		Right Canopy Coverage (%)	100	1					
		Left Buffer Width (ft)	70	0.77					
		Right Buffer Width (ft)	70	0.77					
		Left Basal Area (sq.ft/acre)							
		Right Basal Area (sq.ft/acre)							
		Left Stem Density (stems/acre)	210	0.4					
		Right Stem Density (stems/acre)	210	0.4					
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value							
	Bed Form Diversity	Pool Spacing Ratio			1.00				
		Pool Depth Ratio	1.3	1					
		Percent Riffle	70	1					
		Aggradation Ratio							
	Plan Form	Sinuosity	1.15	0	0.00				
Physicochemical	Temperature	Summer Daily Maximum (°F)							
	Bacteria	Fecal Coliform (Cfu/100 ml)							
	Organic Carbon	Leaf Litter Processing Rate							
		Percent Shredders							
	Nitrogen	Total Nitrogen (mg/L)							
	Phosphorus	Total Phosphorus (mg/L)							
Biology	Macros	Biotic Index							
		EPT Taxa Present							
	Fish	North Carolina Index of Biotic Integrity							

Catchment Assessment Form

Rater(s): K. VanStell

Date: 1/24/20

Overall Catchment Condition	**F**
Restoration Potential	**Level 3 - Geomorphology**

Purpose: This form is used to determine the project's restoration potential.

CATCHMENT ASSESSMENT

Categories		Description of Catchment Condition			Rating
		Poor	**Fair**	**Good**	**(P/F/G)**
1	Concentrated Flow (Hydrology)	Potential for concentrated flow/impairments immediately upstream of the project and no treatments are in place	Some potential for concentrated flow/impairments to reach restoration site, however, measures are in place to protect resources	No potential for concentrated flow/impairments from adjacent land use	F
2	Impervious cover (Hydrology)	Greater than 25%	Between 10% and 25%	Less than 10%	G
3	Land Use Change (Hydrology)	Rapidly urbanizing/urban	Single family homes/suburban	Rural communities/slow growth or primarily forested	G
4	Distance to Roads (Hydrology)	Roads located in or adjacent to project reach and/or major roads proposed in 10 year DOT plans	No roads in or adjacent to project reach. No more than one major road proposed in 10 year DOT plans.	No roads in or adjacent to project reach. No proposed roads in 10 year DOT plans.	F
5	Percent Forested (Hydrology)	<= 20%	>20% and <70%	>=70%	F
6	Riparian Vegetation (Geomorphology)	<50% of contributing stream length has > 25 ft corridor width	50-80% of contributing stream length has > 25 ft corridor width	>80% of contributing stream length has > 25 ft corridor width	F
7	Sediment Supply (Geomorphology)	High sediment supply from upstream bank erosion and surface runoff	Moderate sediment supply from upstream bank erosion and surface runoff	Low sediment supply. Upstream bank erosion and surface runoff is minimal	G
8	Located on or downstream of a 303(d) listed stream TMDL list (Physicochemical)	On, upstream, or downstream of 303(d) and no TMDL/WS Mgmt plan to address deficiencies	On, upstream, or downstream of 303(d) and TMDL/WS Mgmt plan addressing deficiencies	Not on 303(d) list	G
9	Agricultural Land Use (Physicochemical)	Livestock access to stream and/or intensive cropland immediately upstream of project reach.	Livestock access to stream and/or intensive cropland upstream of project reach. A sufficient reach of stream is between Ag. land use and project reach.	There is little to no agricultural land uses or the livestock or cropland is far enough away from project reach to cause no impact to water quality or biology.	F
10	NPDES Permits (Physicochemical)	Many NPDES permits within catchment or some within one mile of project reach	A few NPDES permits within catchment and none within one mile of project reach	No NPDES permits within catchment and none within one mile of project reach	G
11	Specific Conductance (uS/cm at 25oC) (Physicochemical)	Piedmont = >229; Blue Ridge = >66	Piedmont = 78-229; Blue Ridge = 41-66	Piedmont = <78; Blue Ridge = <41	N/A
12	Watershed impoundments (Biology)	Impoundment(s) located within 1 mile upstream or downstream of project area and/or has a negative effect on project area and fish passage	No impoundment within 1 mile upstream or downstream of project area OR impoundment does not adversely affect project area but a blockage could exist outside of 1 mile and impact fish passage	No impoundment upstream or downstream of project area OR impoundment provides beneficial effect on project area and allows for fish passage	G
13	Organism Recruitment (Biology)	Channel immediately upstream or downstream of project reach is concrete, piped, or hardened.	Channel immediately upstream or downstream of project reach has native bed and bank material, but is impaired.	Channel immediately upstream or downstream of project reach has native bed and bank material.	F
14	Percent of Catchment being Enhanced or Restored	Less than 40% of the total catchment area is draining to the project reach.	40 to 60% of the total catchment area is draining to the project reach.	Greater than 60% of the total catchment area is draining to the project reach.	G
15	Other				

Site Information and Performance Standard Stratification	
Project Name:	Hornpipe Branch Tribs
Reach ID:	MS3
Restoration Potential:	Level 3 - Geomorphology
Existing Stream Type:	G
Proposed Stream Type:	C
Region:	Coastal Plain
Drainage Area (sqmi):	0.517
Proposed Bed Material:	Sand
Existing Stream Length (ft)	1337
Proposed Stream Length (ft):	1529
Stream Slope (%):	0.041
Flow Type:	Perennial
River Basin:	Neuse
Stream Temperature:	Warmwater
Data Collection Season:	Summer
Valley Type:	Unconfined Alluvial

Notes
1. Users input values that are highlighted based on restoration potential
2. Users select values from a pull-down menu
3. Leave values blank for field values that were not measured

FUNCTIONAL CHANGE SUMMARY	
Exisiting Condition Score (ECS)	0.15
Proposed Condition Score (PCS)	0.47
Change in Functional Condition (PCS - ECS)	0.32
Percent Condition Change	213%
Existing Stream Length (ft)	1337
Proposed Stream Length (ft)	1529
Additional Stream Length (ft)	192
Existing Functional Foot Score (FFS)	201
Proposed Functional Foot Score (FFS)	719
Proposed FFS - Existing FFS	518
Functional Change (%)	258%

BMP FUNCTIONAL CHANGE SUMMARY	
Existing BMP Functional Feet Score (FFS)	1044
Proposed BMP Functional Feet Score (FFS)	1044
Proposed BMP FFS - Existing BMP FFS	0
Functional Change (%)	0%

FUNCTIONAL FEET (FF) SUMMARY	
Existing Stream FFS + Existing BMP FFS	1245
Proposed Stream FFS + Proposed BMP FFS	1763
Total Proposed FFS - Total Existing FFS	518
Functional Change (%)	42%

FUNCTION BASED PARAMETERS SUMMARY

Functional Category	Function-Based Parameters	Existing Parameter	Proposed Parameter
Hydrology	Catchment Hydrology	0.23	0.56
	Reach Runoff	0.57	0.85
Hydraulics	Floodplain Connectivity	0.00	0.89
Geomorphology	Large Woody Debris	0.19	1.00
	Lateral Stability	0.39	1.00
	Riparian Vegetation	0.94	0.76
	Bed Material		
	Bed Form Diversity	0.32	1.00
	Plan Form	0.00	0.00
Physicochemical	Temperature		
	Bacteria		
	Organic Matter		
	Nitrogen		
	Phosphorus		
Biology	Macros		
	Fish		

FUNCTIONAL CATEGORY REPORT CARD

Functional Category	ECS	PCS	Functional Change
Hydrology	0.40	0.71	0.31
Hydraulics	0.00	0.89	0.89
Geomorphology	0.37	0.75	0.38
Physicochemical			
Biology			

EXISTING CONDITION ASSESSMENT / **Roll Up Scoring**

Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Parameter	Category	Category	Overall	Overall
Hydrology	Catchment Hydrology	Curve Number	72	0.23	0.23	0.40	Functioning At Risk	0.15	Not Functioning
	Reach Runoff	Curve Number	72	0.23	0.57				
		Concentrated Flow Points	1	0.69					
		Soil Compaction	20	0.80					
Hydraulics	Floodplain Connectivity	Bank Height Ratio	4.8	0	0.00	0.00	Not Functioning		
		Entrenchment Ratio	1.1	0					
Geomorphology	Large Woody Debris	LWD Index			0.19	0.37	Functioning At Risk		
		# Pieces	8	0.19					
	Lateral Stability	Erosion Rate (ft/yr)			0.39				
		Dominant BEHI/NBS	M/M	0.5					
		Percent Streambank Erosion (%)	30	0.27					
	Riparian Vegetation	Left Canopy Coverage (%)	100	1	0.94				
		Right Canopy Coverage (%)	100	1					
		Left Buffer Width (ft)	80	0.8					
		Right Buffer Width (ft)	130	0.95					
		Left Basal Area (sq.ft/acre)							
		Right Basal Area (sq.ft/acre)							
		Left Stem Density (stems/acre)							
		Right Stem Density (stems/acre)							
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value)							
	Bed Form Diversity	Pool Spacing Ratio	8	0	0.32				
		Pool Depth Ratio	1.2	0.65					
		Percent Riffle	80	0.3					
		Aggradation Ratio							
	Plan Form	Sinuosity	1.02	0	0.00				
Physicochemical	Temperature	Summer Daily Maximum (°F)							
	Bacteria	Fecal Coliform (Cfu/100 ml)							
	Organic Carbon	Leaf Litter Processing Rate							
		Percent Shredders							
	Nitrogen	Total Nitrogen (mg/L)							
	Phosphorus	Total Phosphorus (mg/L)							
Biology	Macros	Biotic Index							
		EPT Taxa Present							
	Fish	North Carolina Index of Biotic Integrity							

PROPOSED CONDITION ASSESSMENT / **Roll Up Scoring**

Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Parameter	Category	Category	Overall	Overall
Hydrology	Catchment Hydrology	Curve Number	61	0.56	0.56	0.71	Functioning	0.47	Functioning At Risk
	Reach Runoff	Curve Number	61	0.56	0.85				
		Concentrated Flow Points	0	1					
		Soil Compaction	30	1.00					
Hydraulics	Floodplain Connectivity	Bank Height Ratio	1	1	0.89	0.89	Functioning		
		Entrenchment Ratio	3	0.77					
Geomorphology	Large Woody Debris	LWD Index			1.00	0.75	Functioning		
		# Pieces	30	1					
	Lateral Stability	Erosion Rate (ft/yr)			1.00				
		Dominant BEHI/NBS	L/L	1					
		Percent Streambank Erosion (%)	5	1					
	Riparian Vegetation	Left Canopy Coverage (%)	100	1	0.76				
		Right Canopy Coverage (%)	100	1					
		Left Buffer Width (ft)	80	0.8					
		Right Buffer Width (ft)	130	0.95					
		Left Basal Area (sq.ft/acre)							
		Right Basal Area (sq.ft/acre)							
		Left Stem Density (stems/acre)	210	0.4					
		Right Stem Density (stems/acre)	210	0.4					
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value)							
	Bed Form Diversity	Pool Spacing Ratio			1.00				
		Pool Depth Ratio	1.3	1					
		Percent Riffle	70	1					
		Aggradation Ratio							
	Plan Form	Sinuosity	1.17	0	0.00				
Physicochemical	Temperature	Summer Daily Maximum (°F)							
	Bacteria	Fecal Coliform (Cfu/100 ml)							
	Organic Carbon	Leaf Litter Processing Rate							
		Percent Shredders							
	Nitrogen	Total Nitrogen (mg/L)							
	Phosphorus	Total Phosphorus (mg/L)							
Biology	Macros	Biotic Index							
		EPT Taxa Present							
	Fish	North Carolina Index of Biotic Integrity							

Design Plan - Proposed Design Criteria

Hornpipe Branch Tributaries

Stream Reach: MS1	Existing Site Data		Composite Reference Ratios		Proposed Design Values	
Parameter	**MIN**	**MAX**	**MIN**	**MAX**	**MIN**	**MAX**
Drainage Area, DA (sq mi)	0.286		---		0.286	
Stream Type (Rosgen)	incised E5/channelized		DA/E5		DA/E5	
Bankfull Discharge, Qbkf (cfs)	4.0		---		4.0	
Bankfull Riffle XSEC Area, Abkf (sq ft)	3.8	3.8	---		3.7	
Bankfull Mean Velocity, Vbkf (ft/s)	1.1				1.1	
Bankfull Riffle Width, Wbkf (ft)	4.9	4.2	---	---	6.9	
Bankfull Riffle Mean Depth, Dbkf (ft)	0.8	0.9	---	---	0.5	
Width to Depth Ratio, W/D (ft/ft)	4.7	4.7	10.0	15.0	13.0	
Width Floodprone Area, Wfpa (ft)	9.0	9.0	---	---	15.0	30.0
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	1.8	2.1	>2.2	>2.2	2.2	4.3
Riffle Max Depth @ bkf, Dmax (ft)	1.2	1.2	---	---	0.7	
Riffle Max Depth Ratio, Dmax/Dbkf	1.5	1.3	1.1	1.5	1.4	1.4
Bank Height Ratio, Dtob/Dmax (ft/ft)	2.6	2.6	1.0	1.1	1.0	1.1
Meander Length, Lm (ft)	---	---	---	---	N/A	N/A
Meander Length Ratio, Lm/Wbkf	---	---	---	---	N/A	N/A
Radius of Curvature, Rc (ft)	---	---	---	---	N/A	N/A
Rc Ratio, Rc/Wbkf	---	---	---	---	N/A	N/A
Belt Width, Wblt (ft)	---	---	---	---	N/A	N/A
Meander Width Ratio, Wblt/Wbkf	---	---	---	---	N/A	N/A
Sinuosity, K	1.01		---	---	1.02	
Valley Slope, Sval (ft/ft)	0.0050		0.0050	0.0150	0.0050	
Channel Slope, Schan (ft/ft)	0.0050		---	---	0.0049	
Slope Riffle, Sriff (ft/ft)	0.0050	0.0090	---	---	0.0040	0.0085
Riffle Slope Ratio, Sriff/Schan	1.0	1.8	1.2	1.5	0.8	1.7
Slope Pool, Spool (ft/ft)	0.0000	0.0010	---	---	0.0000	0.0010
Pool Slope Ratio, Spool/Schan	0.0	0.2	0.0	0.2	0.0	0.2
Pool Max Depth, Dmaxpool (ft)	0.7	1.3	---	---	1.0	1.5
Pool Max Depth Ratio, Dmaxpool/Dbkf	0.9	1.4	1.5	3.5	1.9	2.8
Pool Width, Wpool (ft)	7.5	9.8	---	---	8.0	10.5
Pool Width Ratio, Wpool/Wbkf	1.5	2.3	1.2	1.7	1.2	1.5
Pool-Pool Spacing, Lps (ft)	38.0	87.0	---	---	30.0	50.0
Pool-Pool Spacing Ratio, Lps/Wbkf	7.8	20.7	3.5	7.0	4.3	7.2

Design Plan - Proposed Design Criteria

Hornpipe Branch Tributaries

Stream Reach: MS2	**Existing Site Data**		**Composite Reference Ratios**		**Proposed Design Values**	
Parameter	**MIN**	**MAX**	**MIN**	**MAX**	**MIN**	**MAX**
Drainage Area, DA (sq mi)	0.347		---		0.347	
Stream Type (Rosgen)	incised E5/ channelized		E5/C5		E5/C5	
Bankfull Discharge, Qbkf (cfs)	4.5		---		4.5	
Bankfull Riffle XSEC Area, Abkf (sq ft)	4.4	4.4	---		4.3	
Bankfull Mean Velocity, Vbkf (ft/s)	1.0				1.0	
Bankfull Riffle Width, Wbkf (ft)	4.5	4.5	---	---	7.5	
Bankfull Riffle Mean Depth, Dbkf (ft)	1.0	1.0	---	---	0.6	
Width to Depth Ratio, W/D (ft/ft)	4.5	4.5	10.0	15.0	13.0	
Width Floodprone Area, Wfpa (ft)	8.7	8.7	---	---	29.0	47.0
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	2.0	2.0	>2.2	>2.2	3.9	6.3
Riffle Max Depth @ bkf, Dmax (ft)	1.3	1.3	---	---	0.8	
Riffle Max Depth Ratio, Dmax/Dbkf	1.3	1.3	1.1	1.5	1.4	1.4
Bank Height Ratio, Dtob/Dmax (ft/ft)	2.2	2.2	1.0	1.1	1.0	1.1
Meander Length, Lm (ft)	---	---	---	---	53.0	98.0
Meander Length Ratio, Lm/Wbkf	---	---	7.0	14.0	7.1	13.1
Radius of Curvature, Rc (ft)	---	---	---	---	15.0	23.0
Rc Ratio, Rc/Wbkf	---	---	2.0	3.0	2.0	3.1
Belt Width, Wblt (ft)	---	---	---	---	27.0	48.0
Meander Width Ratio, Wblt/Wbkf	---	---	3.5	8.0	3.6	6.4
Sinuosity, K	1.01		1.2	1.4	1.11	
Valley Slope, Sval (ft/ft)	0.0041		0.0050	0.0150	0.0041	
Channel Slope, Schan (ft/ft)	0.0041		---	---	0.0037	
Slope Riffle, Sriff (ft/ft)	0.0035	0.0050	---	---	0.003	0.006
Riffle Slope Ratio, Sriff/Schan	0.9	1.2	1.2	1.7	0.8	1.6
Slope Pool, Spool (ft/ft)	0.0000	0.0031	---	---	0.0010	0.0030
Pool Slope Ratio, Spool/Schan	0.0	0.8	0.0	0.2	0.0	0.0
Pool Max Depth, Dmaxpool (ft)	2.9	3.3	---	---	1.0	1.6
Pool Max Depth Ratio, Dmaxpool/Dbkf	2.9	3.3	1.5	3.5	1.7	2.8
Pool Width, Wpool (ft)	10.1	18.7	---	---	9.0	11.2
Pool Width Ratio, Wpool/Wbkf	0.9	1.3	1.2	1.7	1.2	1.5
Pool-Pool Spacing, Lps (ft)	33.0	104.0	---	---	29.0	53.0
Pool-Pool Spacing Ratio, Lps/Wbkf	7.3	23.1	3.5	7.0	3.9	7.1

Design Plan - Proposed Design Criteria

Hornpipe Branch Tributaries

Stream Reach: MS3	**Existing Site Data**		**Composite Reference Ratios**		**Proposed Design Values**	
Parameter	**MIN**	**MAX**	**MIN**	**MAX**	**MIN**	**MAX**
Drainage Area, DA (sq mi)	0.517		---		0.517	
Stream Type (Rosgen)	F5		E5/C5		E5/C5	
Bankfull Discharge, Qbkf (cfs)	6.6		---		6.6	
Bankfull Riffle XSEC Area, Abkf (sq ft)	4.4	4.4	---		5.4	
Bankfull Mean Velocity, Vbkf (ft/s)	1.5				1.2	
Bankfull Riffle Width, Wbkf (ft)	9.1	11.4	---	---	8.4	
Bankfull Riffle Mean Depth, Dbkf (ft)	0.7	0.7	---	---	0.6	
Width to Depth Ratio, W/D (ft/ft)	12.7	12.7	10.0	15.0	13.0	
Width Floodprone Area, Wfpa (ft)	8.8	8.8	---	---	19.0	30.0
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	1.1	1.1	>2.2	>2.2	2.3	3.6
Riffle Max Depth @ bkf, Dmax (ft)	0.8	0.8	---	---	0.9	
Riffle Max Depth Ratio, Dmax/Dbkf	1.1	1.1	1.1	1.5	1.1	1.4
Bank Height Ratio, Dtob/Dmax (ft/ft)	4.8	4.8	1.0	1.1	1.0	1.1
Meander Length, Lm (ft)	---	---	---	---	60.0	110.0
Meander Length Ratio, Lm/Wbkf	---	---	7.0	14.0	7.2	13.1
Radius of Curvature, Rc (ft)	---	---	---	---	17.0	25.0
Rc Ratio, Rc/Wbkf	---	---	2.0	3.0	2.0	3.0
Belt Width, Wblt (ft)	---	---	---	---	29.0	62.0
Meander Width Ratio, Wblt/Wbkf	---	---	3.5	8.0	3.5	7.4
Sinuosity, K	1.02		1.2	1.4	1.18	
Valley Slope, Sval (ft/ft)	0.0044		0.0050	0.0150	0.0044	
Channel Slope, Schan (ft/ft)	0.0040		---	---	0.0037	
Slope Riffle, Sriff (ft/ft)	0.0030	0.0040	---	---	0.0045	0.0073
Riffle Slope Ratio, Sriff/Schan	0.8	1.0	1.2	1.5	1.2	2.0
Slope Pool, Spool (ft/ft)	0.0000	0.0031	---	---	0.0000	0.0010
Pool Slope Ratio, Spool/Schan	0.0	0.8	0.0	0.2	0.0	0.3
Pool Max Depth, Dmaxpool (ft)	2.9	3.3	---	---	1.5	2.1
Pool Max Depth Ratio, Dmaxpool/Dbkf	4.1	4.7	1.5	3.5	2.3	3.3
Pool Width, Wpool (ft)	10.1	18.7	---	---	10.4	12.5
Pool Width Ratio, Wpool/Wbkf	0.9	1.3	1.2	1.7	1.2	1.5
Pool-Pool Spacing, Lps (ft)	33.0	104.0	---	---	42.0	62.0
Pool-Pool Spacing Ratio, Lps/Wbkf	3.6	9.1	3.5	7.0	5.0	7.4

Design Plan - Proposed Design Criteria

Hornpipe Branch Tributaries

Stream Reach: UT1	**Existing Site Data**		**Composite Reference Ratios**		**Proposed Design Values**	
Parameter	**MIN**	**MAX**	**MIN**	**MAX**	**MIN**	**MAX**
Drainage Area, DA (sq mi)	0.071		---		0.071	
Stream Type (Rosgen)	incised E5/ channelized		DA/E5		DA	
Bankfull Discharge, Qbkf (cfs)	1.4		---		1.4	
Bankfull Riffle XSEC Area, Abkf (sq ft)	1.6	1.6	---		1.2	
Bankfull Mean Velocity, Vbkf (ft/s)	0.9				1.2	
Bankfull Riffle Width, Wbkf (ft)	4.3	4.5	---	---	4.4	
Bankfull Riffle Mean Depth, Dbkf (ft)	0.37	0.77	---	---	0.3	
Width to Depth Ratio, W/D (ft/ft)	6.8	7.4	10.0	15.0	16.0	
Width Floodprone Area, Wfpa (ft)	4.4	5.6	---	---	15.0	30.0
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	1.0	1.6	>2.2	>2.2	3.4	6.8
Riffle Max Depth @ bkf, Dmax (ft)	0.5	0.7	---	---	0.3	
Riffle Max Depth Ratio, Dmax/Dbkf	1.3	2.7	1.1	1.5	1.2	1.2
Bank Height Ratio, Dtob/Dmax (ft/ft)	4.7	6.0	1.0	1.1	1.0	1.1
Meander Length, Lm (ft)	---	---	---	---	N/A	N/A
Meander Length Ratio, Lm/Wbkf	---	---	---	---	N/A	N/A
Radius of Curvature, Rc (ft)	---	---	---	---	N/A	N/A
Rc Ratio, Rc/Wbkf	---	---	---	---	N/A	N/A
Belt Width, Wblt (ft)	---	---	---	---	N/A	N/A
Meander Width Ratio, Wblt/Wbkf	---	---	---	---	N/A	N/A
Sinuosity, K	1.06		---	---	1.09	
Valley Slope, Sval (ft/ft)	0.0065		0.0050	0.0150	0.0065	
Channel Slope, Schan (ft/ft)	0.0065		---	---	0.0060	
Slope Riffle, Sriff (ft/ft)	0.0050	0.0011	---	---	0.0025	0.0085
Riffle Slope Ratio, Sriff/Schan	0.8	0.2	1.2	1.5	0.4	1.4
Slope Pool, Spool (ft/ft)	0.0000	0.0010	---	---	0.0000	0.0015
Pool Slope Ratio, Spool/Schan	0.0	0.2	0.0	0.2	0.0	0.3
Pool Max Depth, Dmaxpool (ft)	0.8	1.2	---	---	0.5	0.9
Pool Max Depth Ratio, Dmaxpool/Dbkf	2.2	1.6	1.5	3.5	1.8	3.3
Pool Width, Wpool (ft)	6.8	7.9	---	---	5.5	7.5
Pool Width Ratio, Wpool/Wbkf	0.9	1.3	1.2	1.7	1.3	1.7
Pool-Pool Spacing, Lps (ft)	35.0	71.0	---	---	20.0	50.0
Pool-Pool Spacing Ratio, Lps/Wbkf	8.1	15.8	3.5	7.0	4.6	11.4

Design Plan - Proposed Design Criteria

Hornpipe Branch Tributaries

Stream Reach: UT2	**Existing Site Data**		**Composite Reference Ratios**		**Proposed Design Values**	
Parameter	**MIN**	**MAX**	**MIN**	**MAX**	**MIN**	**MAX**
Drainage Area, DA (sq mi)	0.050		---		0.050	
Stream Type (Rosgen)	incised E5/ ditched		DA/E5		DA	
Bankfull Discharge, Qbkf (cfs)	1.2		---		1.2	
Bankfull Riffle XSEC Area, Abkf (sq ft)	1.1	1.1	---		1.2	
Bankfull Mean Velocity, Vbkf (ft/s)	1.1				1.0	
Bankfull Riffle Width, Wbkf (ft)	2.7	2.7	---	---	4.4	
Bankfull Riffle Mean Depth, Dbkf (ft)	0.41	0.44	---	---	0.3	
Width to Depth Ratio, W/D (ft/ft)	6.8	6.8	10.0	15.0	16.0	
Width Floodprone Area, Wfpa (ft)	4.4	4.4	---	---	15.0	30.0
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	1.6	1.6	>2.2	>2.2	3.4	6.8
Riffle Max Depth @ bkf, Dmax (ft)	0.7	0.7	---	---	0.3	
Riffle Max Depth Ratio, Dmax/Dbkf	1.7	2.7	1.1	1.5	1.2	1.2
Bank Height Ratio, Dtob/Dmax (ft/ft)	4.7	4.7	1.0	1.1	1.0	1.1
Meander Length, Lm (ft)	---	---	---	---	N/A	N/A
Meander Length Ratio, Lm/Wbkf	---	---	---	---	N/A	N/A
Radius of Curvature, Rc (ft)	---	---	---	---	N/A	N/A
Rc Ratio, Rc/Wbkf	---	---	---	---	N/A	N/A
Belt Width, Wblt (ft)	---	---	---	---	N/A	N/A
Meander Width Ratio, Wblt/Wbkf	---	---	---	---	N/A	N/A
Sinuosity, K	1.06		---	---	1.07	
Valley Slope, Sval (ft/ft)	0.0071		0.0050	0.0150	0.0071	
Channel Slope, Schan (ft/ft)	0.0067		---	---	0.0066	
Slope Riffle, Sriff (ft/ft)	0.0050	0.0090	---	---	0.0027	0.0099
Riffle Slope Ratio, Sriff/Schan	0.7	1.3	1.2	1.5	0.4	1.5
Slope Pool, Spool (ft/ft)	0.0000	0.0010	---	---	0.0000	0.0010
Pool Slope Ratio, Spool/Schan	0.0	0.1	0.0	0.2	0.0	0.2
Pool Max Depth, Dmaxpool (ft)	1.3	1.3	---	---	0.6	0.9
Pool Max Depth Ratio, Dmaxpool/Dbkf	3.2	3.0	1.5	3.5	2.2	3.3
Pool Width, Wpool (ft)	4.7	6.6	---	---	5.5	7.5
Pool Width Ratio, Wpool/Wbkf	0.9	1.3	1.2	1.7	1.3	1.7
Pool-Pool Spacing, Lps (ft)	31.0	68.0	---	---	20.0	50.0
Pool-Pool Spacing Ratio, Lps/Wbkf	11.5	25.2	3.5	7.0	4.6	11.4

PIPE DATA SHEET

Date: 1/15/2020 Sheet 1 of 2

Project Number: 18-006 Project: Hornpipe County: Lenoir Designed By: JNC Reviewed By: KMV

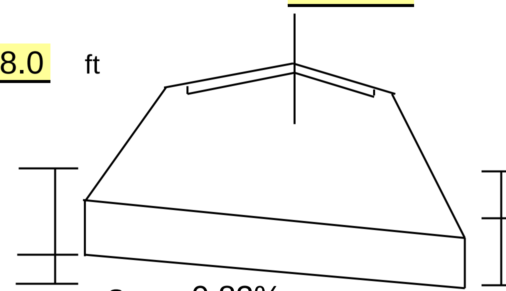
Alignment:	MS1
Station:	
Skew:	90°
Size/Type Pipe:	36" RCP
Type Entrance:	Square Edge
Direction of Flow:	W-SW
Hydrologic Method:	Combination$_1$
H.W. Control Elevation:	98.0
H.W. Control Feature:	Dirt Road

GP Elev.: 98.0 ft

Shoulder Elev.: 98.0 ft

Inlet Ground Elev.: ft

Outlet Ground Elev. H: ft



So= 0.83%

Inlet Invert Elev.: 93.20 ft L= 24.0 ft Outlet Inv. Elev. 93.00 ft

RCP=.012, CMP=.024

n= 0.012

Plan Summary Data

Drainage Area:	0.27 mi
Design Freq.:	10 yr
Design Disch.:	10 cfs
Design H.W. Elev.:	95.7 ft
Q100 Disch.:	18 cfs
Q100 Elev.:	101.36
Overtopping Freq.:	10-25 yr
Overtopping Disch.:	52 cfs
Overtopping Elev.:	97.22

TW Channel Specs.: Slope: 0.005 Lt. Side Slope= 2.5

Base Width= 3.3 n= 0.04 Rt. Side Slope= 2.5

BARRELS SIZE in	BARRELS No. Of Pipes	FREQ YR	TW ft	Q ft^3/s	Nat. H.W. ft	Allow. H.W. ft	Inlet Control HW/D ft/ft	Inlet Control HW (ft) ft		Outlet Control Ke	Outlet Control d_c ft	Outlet Control $(d_c+D)/2$ ft	Outlet Control h_o ft	Outlet Control H ft	Outlet Control LS_O ft	Outlet Control HW ft	HW ELEV.	V_o* ft/s	Remarks
36	1	5	1.2	35	1	3.0	0.96	2.88		0.5	1.92	2.46	2.46	0.620	0.20	2.88	96.08		INLET CONTROL
36	1	10	1.3	45	1	3.0	1.15	3.45		0.2	2.23	2.62	2.62	0.855	0.20	3.27	96.65		INLET CONTROL
36	1	50	1.6	77	1	3.0	1.98	5.94		0.5	3.00	3.00	3.00	3.058	0.20	5.86	99.14		INLET CONTROL
36	1	100	1.8	97	1	3.0	2.72	8.16		0.5	3.00	3.00	3.00	4.826	0.20	7.63	101.36		INLET CONTROL
36	1	10-25	1.4	53	1	3.0	1.34	4.02		0.5	2.46	2.73	2.73	1.438	0.20	3.97	97.22		INLET CONTROL

Notes & Calculations

1. Combination of USGS Regional Regression flow data for rural coastal plains, Rational Method, and the NCDOT Hdrologic Charts was used for the hydrologic method. 2.
Current Invert elevations are assumed. Need to be updated when able
3. RCP is not confirmed with landowners.
4. Top elevation is assumed. Not confirmed.

*V_o is partial flow velocity.

SUMMARY AND RECOMMENDATIONS:

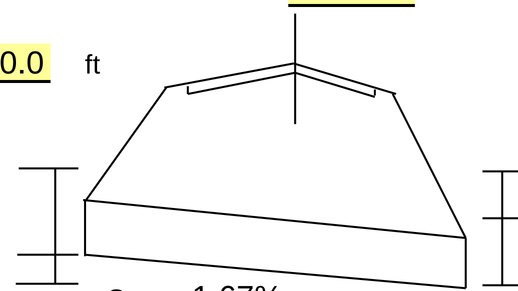
print date: 2/20/2020

PIPE DATA SHEET

Date: 1/14/2020
Project Number: 18-006
Project: Hornpipe
County: Lenoir
Designed By: JNC
Sheet 2 of 2
Reviewed By: KMV

Alignment: MS2
Station:
Skew: 90°
Size/Type Pipe: (2) 30" RCP
Type Entrance: Projecting
Direction of Flow: S-SW
Hydrologic Method: Combination_1
H.W. Control Elevation: 89 ft
H.W. Control Feature: Dirt Road

GP Elev.: 90.0 ft
Shoulder Elev.: 90.0 ft
Inlet Ground Elev.: ft
Outlet Ground Elev. H: ft



So= 1.67%
L= 24.0 ft
Inlet Invert Elev.: 85.80 ft
Outlet Inv. Elev. 85.40 ft

RCP=.012, CMP=.024
n= 0.012

TW Channel Specs.: Slope: 0.0035 Lt. Side Slope= 2.5
Base Width= 3.6 n= 0.04 Rt. Side Slope= 2.5

Plan Summary Data

Drainage Area: 0.35 mi
Design Freq.: 10 yr
Design Disch.: 57.9 ft
Design H.W. Elev.: 88.625 ft
Q100 Disch.: 124.4 ft
Q100 Elev.: 92.8 ft
Overtopping Freq.: 10-25 yr
Overtopping Disch.: 90 cfs
Overtopping Elev.: 90.2 ft

BARRELS			TW	Q	Nat.	Allow.	Inlet Control		Outlet Control							HW	V_o*	
SIZE	No. Of	FREQ			H.W.	H.W.	HW/D	HW (ft)	Ke	d_c	$(d_c+D)/2$	h_o	H	LS_O	HW	ELEV.		Remarks
in	Pipes	YR	ft	ft^3/s	ft	ft	ft/ft	ft		ft	ft	ft	ft	ft	ft		ft/s	
30	2	5	1.1	45	1	3.4	0.96	2.40	0.2	1.60	2.05	2.05	0.443	0.40	2.09	88.20		INLET CONTROL
30	2	10	1.2	58	1	3.4	1.13	2.83	0.2	1.87	2.19	2.19	0.749	0.40	2.54	88.63		INLET CONTROL
30	2	50	1.4	99	1	3.4	1.98	4.95	0.2	2.50	2.50	2.50	2.186	0.40	4.29	90.75		INLET CONTROL
30	2	100	1.5	124	1	3.4	2.80	7.00	0.2	2.50	2.50	2.50	3.459	0.40	5.56	92.80		INLET CONTROL
30	2	10-25	1.3	90	1	3.4	1.76	4.40	0.2	2.44	2.47	2.47	1.810	0.40	3.88	90.20		INLET CONTROL

Notes & Calculations

1. Combination of USGS Regional Regression flow data for rural coastal plains, Rational Method, and the NCDOT Hdrologic Charts was used for the hydrologic method. 2.
Current Invert elevations are assumed. Need to be updated when able
3. RCP is not confirmed with landowners.
4. Top elevation is assumed. Not confirmed.

*V_o is partial flow velocity.

SUMMARY AND RECOMMENDATIONS:

print date: 2/20/2020

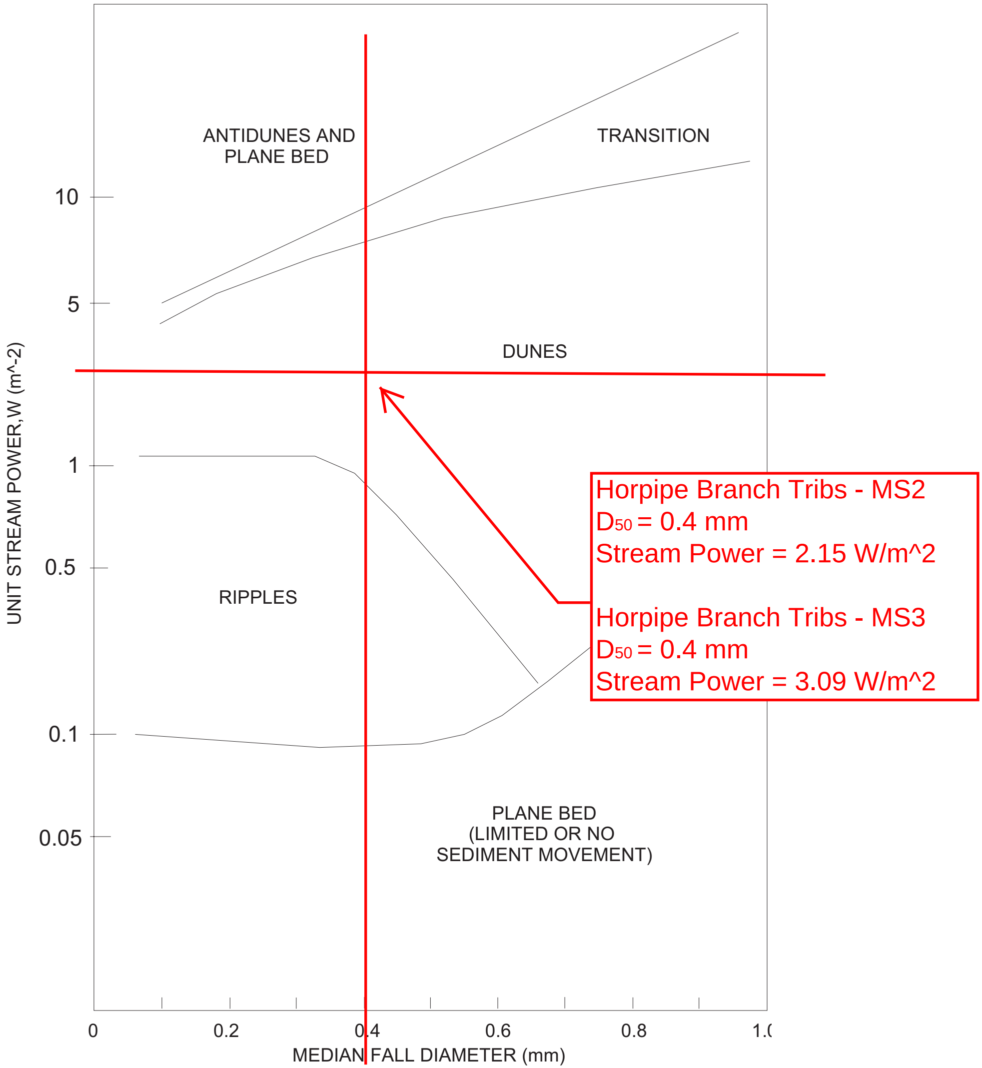
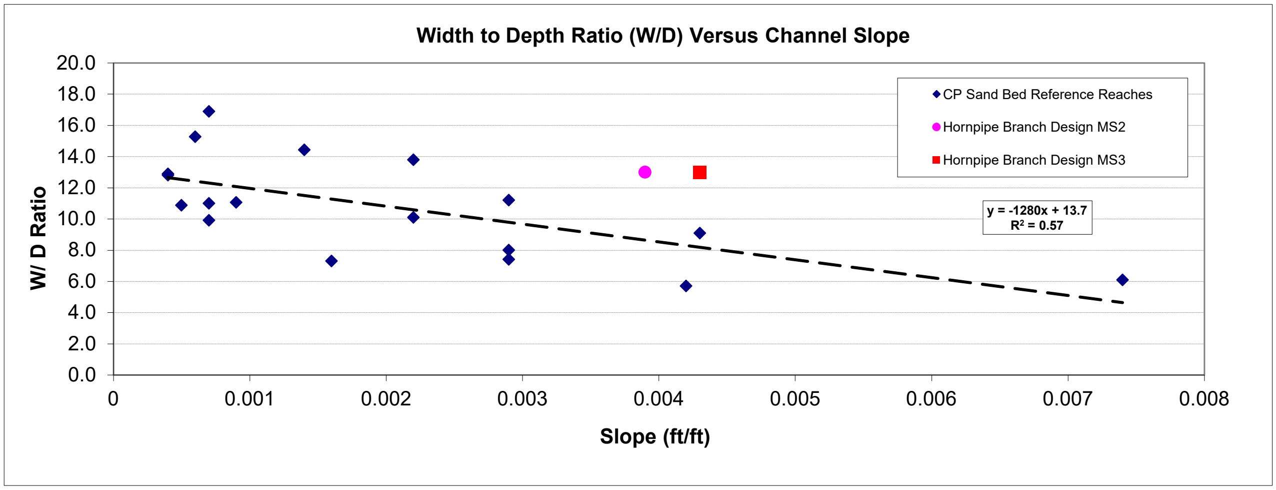
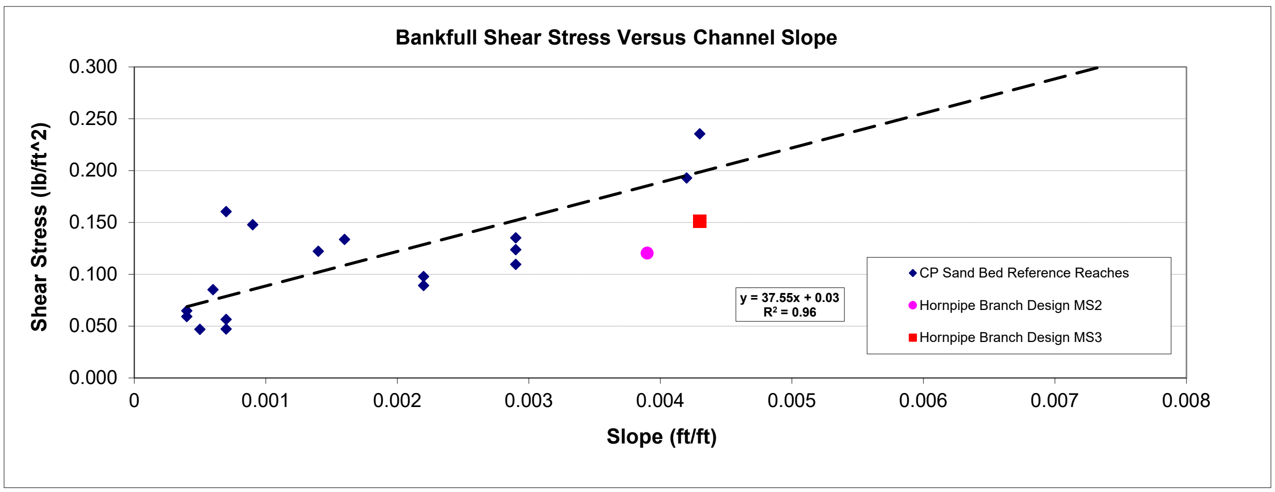


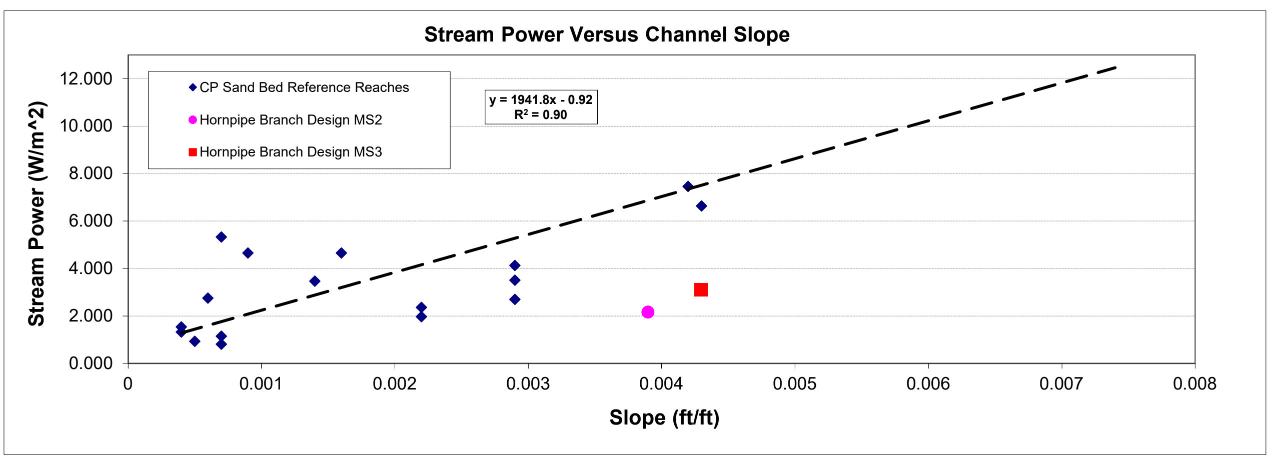
Figure 1.1 Median Fall Diameter versus Unit Stream Power for Sand Bed Forms (after Knighton ,1998, and Simons and Richardson, 1966).



Width to Depth Ratio (W/D) Versus Channel Slope
W/ D Ratio
Slope (ft/ft)
CP Sand Bed Reference Reaches
Hornpipe Branch Design MS2
Hornpipe Branch Design MS3
y = -1280x + 13.7
R² = 0.57



Bankfull Shear Stress Versus Channel Slope
Shear Stress (lb/ft^2)
Slope (ft/ft)
CP Sand Bed Reference Reaches
Hornpipe Branch Design MS2
Hornpipe Branch Design MS3
y = 37.55x + 0.03
R² = 0.96



Stream Power Versus Channel Slope
Stream Power (W/m^2)
Slope (ft/ft)
CP Sand Bed Reference Reaches
Hornpipe Branch Design MS2
Hornpipe Branch Design MS3
y = 1941.8x - 0.92
R² = 0.90

Catchment Area	27.7	BMP1, MS1
Pervious Area	27.57	
Impervious Area	0.13	

	Output
	Input

1246175.4

The Simple Method		
R_V = 0.05 + 0.9 * I_A	Step 1 in the Simple Method	
R_V	0.054223827	Runoff coefficient (unitless)
I_A	0.004693141	Impervious fraction [impervious portion of drainage area (ac)/drainage area (ac)], (unitless)
V = 3630 * R_D * R_V * A	Step 2 in the Simple Method	
V	5452.26	Volume of runoff that must be controlled for the design storm (cubic feet)
V	1.5020	Volume of runoff that must be controlled for the design storm (acre-in)
R_D	1.0	Design storm rainfall depth (in) (Typically 1.0" or 1.5")
A	27.7	Watershed area (ac)

***CN Method in this spreadsheet is for 2 CN areas only. The equations may need to be modified if using multiple CNs or use a composite pervious CN.

SCS Curve Number Method		
Q* = (P - 0.2S)^2 / (P + 0.8S)		
Q* (From Impervious)	0.00	Runoff depth (in)
P	1.0	Rainfall depth (in) (Typically 1.0" or 1.5")
S	4.26	Potential maximum retention after rainfall begins (in)
S = (1000 / CN) - 10	4.26	S is related to the soil and surface characteristics through the curve number (CN)
CN (Impervious)	70.1	Related to hydrologic soil group and ground cover. (Refer to DWQ Design Manual for CN Tables)
S = (1000 / CN) - 10	4.26	
CN (Pervious)	70.1	
Q* (From Pervious)	0.01	
P	1.00	
S	4.26	
Q*total	0.01	(in)
Soil Type	Pactolus loamy sand	http://websoilsurvey.nrcs.usda.gov/app/
Hydrologic Soil Group SCS (1986)	A	Refer to DWQ Design Manual after the soil series in the area of interest is identified

BMP Sizing Reqs		
V = A(Q*)	0.18	SCS Method Volume of Runoff (ac-in) Required Storage Volume
V	647.03	SCS Method Volume of Runoff (cubic feet) Required Storage Volume
V	4840.13	SCS Method Volume of Runoff (gallons) Required Storage Volume
V	1.50	Simple Method Volume of Runoff (ac-in) Required Storage Volume
V	5452	Simple Method Volume of Runoff (cubic feet) Required Storage Volume
Required Ponding Depth	12.0	Depends on desired vegetation type and inundation time. Usually 6-12" (in)
Required BMP Surface Area	0.015	(ac) SCS Method
Required BMP Surface Area	647.032	(ft^2) SCS Method
Required BMP Surface Area	0.125	(ac) Simple Method
Required BMP Surface Area	5452.260	(ft^2) Simple Method
Actual BMP Surface Area	0.069	(ac) Measured in Cadd, GIS or by hand.
Actual BMP Surface Area	3000	(ft^2)
Actual BMP Storage Volume	3000	(ft^3)

Per DWQ BMP design manual, the BMP must be designed to treat a volume at least as large as the volume calculated using the simple method

DWQ recommends 9" but requires ponding depth to be less then 12"

Catchment Area	1.4	BMP2, MS1
Pervious Area	1.40	
Impervious Area	0.00	

	Output
	Input

1246175.4

The Simple Method		
$R_V = 0.05 + 0.9 * I_A$	Step 1 in the Simple Method	
R_V	0.05	Runoff coefficient (unitless)
I_A	0	Impervious fraction [impervious portion of drainage area (ac)/drainage area (ac)], (unitless)
$V = 3630 * R_D * R_V * A$	Step 2 in the Simple Method	
V	254.1	Volume of runoff that must be controlled for the design storm (cubic feet)
V	0.0700	Volume of runoff that must be controlled for the design storm (acre-in)
R_D	1.0	Design storm rainfall depth (in) (Typically 1.0" or 1.5")
A	1.4	Watershed area (ac)

***CN Method in this spreadsheet is for 2 CN areas only. The equations may need to be modified if using multiple CNs or use a composite pervious CN.

SCS Curve Number Method		
Q* = (P - 0.2S)^2 / (P + 0.8S)		
Q* (From Impervious)	0.00	Runoff depth (in)
P	1.0	Rainfall depth (in) (Typically 1.0" or 1.5")
S	5.15	Potential maximum retention after rainfall begins (in)
S = (1000 / CN) - 10	5.15	S is related to the soil and surface characteristics through the curve number (CN)
CN (Impervious)	66.0	Related to hydrologic soil group and ground cover. (Refer to DWQ Design Manual for CN Tables)
S = (1000 / CN) - 10	5.15	
CN (Pervious)	66.0	
Q* (From Pervious)	0.00	
P	1.00	
S	5.15	
Q*total	0.00	(in)
Soil Type	Norfolk loamy sand	http://websoilsurvey.nrcs.usda.gov/app/
Hydrologic Soil Group SCS (1986)	A	Refer to DWQ Design Manual after the soil series in the area of interest is identified

BMP Sizing Reqs		
V = A(Q*)	0.00	SCS Method Volume of Runoff (ac-in) Required Storage Volume
V	1.13	SCS Method Volume of Runoff (cubic feet) Required Storage Volume
V	8.47	SCS Method Volume of Runoff (gallons) Required Storage Volume
V	0.07	Simple Method Volume of Runoff (ac-in) Required Storage Volume
V	254	Simple Method Volume of Runoff (cubic feet) Required Storage Volume
Required Ponding Depth	12.0	Depends on desired vegetation type and inundation time. Usually 6-12" (in)
Required BMP Surface Area	0.000	(ac) SCS Method
Required BMP Surface Area	1.132	(ft^2) SCS Method
Required BMP Surface Area	0.006	(ac) Simple Method
Required BMP Surface Area	254.100	(ft^2) Simple Method
Actual BMP Surface Area	0.003	(ac) Measured in Cadd, GIS or by hand.
Actual BMP Surface Area	150	(ft^2)
Actual BMP Storage Volume	150	(ft^3)

Per DWQ BMP design manual, the BMP must be designed to treat a volume at least as large as the volume calculated using the simple method

DWQ recommends 9" but requires ponding depth to be less then 12"

Catchment Area	68.3	BMP3, MS2
Pervious Area	68.30	
Impervious Area	0.00	

	Output
	Input

1246175.4

The Simple Method		
$R_V = 0.05 + 0.9 * I_A$	Step 1 in the Simple Method	
R_V	0.05	Runoff coefficient (unitless)
I_A	0	Impervious fraction [impervious portion of drainage area (ac)/drainage area (ac)], (unitless)
$V = 3630 * R_D * R_V * A$	Step 2 in the Simple Method	
V	12396.45	Volume of runoff that must be controlled for the design storm (cubic feet)
V	3.4150	Volume of runoff that must be controlled for the design storm (acre-in)
R_D	1.0	Design storm rainfall depth (in) (Typically 1.0" or 1.5")
A	68.3	Watershed area (ac)

***CN Method in this spreadsheet is for 2 CN areas only. The equations may need to be modified if using multiple CNs or use a composite pervious CN.

SCS Curve Number Method		
Q* = (P - 0.2S)^2 / (P + 0.8S)		
Q* (From Impervious)	0.00	Runoff depth (in)
P	1.0	Rainfall depth (in) (Typically 1.0" or 1.5")
S	5.54	Potential maximum retention after rainfall begins (in)
S = (1000 / CN) - 10	5.54	S is related to the soil and surface characteristics through the curve number (CN)
CN (Impervious)	64.3	Related to hydrologic soil group and ground cover. (Refer to DWQ Design Manual for CN Tables)
S = (1000 / CN) - 10	5.54	
CN (Pervious)	64.3	
Q* (From Pervious)	0.00	
P	1.00	
S	5.54	
Q*total	0.00	(in)
Soil Type	Norfolk loamy sand	http://websoilsurvey.nrcs.usda.gov/app/
Hydrologic Soil Group SCS (1986)	A	Refer to DWQ Design Manual after the soil series in the area of interest is identified

BMP Sizing Reqs		
V = A(Q*)	0.18	SCS Method Volume of Runoff (ac-in) Required Storage Volume
V	658.09	SCS Method Volume of Runoff (cubic feet) Required Storage Volume
V	4922.86	SCS Method Volume of Runoff (gallons) Required Storage Volume
V	3.41	Simple Method Volume of Runoff (ac-in) Required Storage Volume
V	12396	Simple Method Volume of Runoff (cubic feet) Required Storage Volume
Required Ponding Depth	12.0	Depends on desired vegetation type and inundation time. Usually 6-12" (in)
Required BMP Surface Area	0.015	(ac) SCS Method
Required BMP Surface Area	658.091	(ft^2) SCS Method
Required BMP Surface Area	0.285	(ac) Simple Method
Required BMP Surface Area	12396.450	(ft^2) Simple Method
Actual BMP Surface Area	0.149	(ac) Measured in Cadd, GIS or by hand.
Actual BMP Surface Area	6500	(ft^2)
Actual BMP Storage Volume	6500	(ft^3)

Per DWQ BMP design manual, the BMP must be designed to treat a volume at least as large as the volume calculated using the simple method

DWQ recommends 9" but requires ponding depth to be less then 12"

Catchment Area	16.67	BMP4, UT2
Pervious Area	16.67	
Impervious Area	0.00	

	Output
	Input

The Simple Method		
$R_V = 0.05 + 0.9 * I_A$	Step 1 in the Simple Method	
R_V	0.05	Runoff coefficient (unitless)
I_A	0	Impervious fraction [impervious portion of drainage area (ac)/drainage area (ac)], (unitless)
$V = 3630 * R_D * R_V * A$	Step 2 in the Simple Method	
V	3025.605	Volume of runoff that must be controlled for the design storm (cubic feet)
V	0.8335	Volume of runoff that must be controlled for the design storm (acre-in)
R_D	1.0	Design storm rainfall depth (in) (Typically 1.0" or 1.5")
A	16.67	Watershed area (ac)

1246175.4

***CN Method in this spreadsheet is for 2 CN areas only. The equations may need to be modified if using multiple CNs or use a composite pervious CN.

SCS Curve Number Method		
Q* = (P - 0.2S)^2 / (P + 0.8S)		
Q* (From Impervious)	0.00	Runoff depth (in)
P	1.0	Rainfall depth (in) (Typically 1.0" or 1.5")
S	4.71	Potential maximum retention after rainfall begins (in)
S = (1000 / CN) - 10	4.71	S is related to the soil and surface characteristics through the curve number (CN)
CN (Impervious)	68.0	Related to hydrologic soil group and ground cover. (Refer to DWQ Design Manual for CN Tables)
S = (1000 / CN) - 10	4.71	
CN (Pervious)	68.0	
Q* (From Pervious)	0.00	
P	1.00	
S	4.71	
Q*total	0.00	(in)
Soil Type	Pocalla loamy sand	http://websoilsurvey.nrcs.usda.gov/app/
Hydrologic Soil Group SCS (1986)	A	Refer to DWQ Design Manual after the soil series in the area of interest is identified

BMP Sizing Reqs		
V = A(Q*)	0.02	SCS Method Volume of Runoff (ac-in) Required Storage Volume
V	55.62	SCS Method Volume of Runoff (cubic feet) Required Storage Volume
V	416.05	SCS Method Volume of Runoff (gallons) Required Storage Volume
V	0.83	Simple Method Volume of Runoff (ac-in) Required Storage Volume
V	3026	Simple Method Volume of Runoff (cubic feet) Required Storage Volume
Required Ponding Depth	12.0	Depends on desired vegetation type and inundation time. Usually 6-12" (in)
Required BMP Surface Area	0.001	(ac) SCS Method
Required BMP Surface Area	55.618	(ft^2) SCS Method
Required BMP Surface Area	0.069	(ac) Simple Method
Required BMP Surface Area	3025.605	(ft^2) Simple Method
Actual BMP Surface Area	0.034	(ac) Measured in Cadd, GIS or by hand.
Actual BMP Surface Area	1500	(ft^2)
Actual BMP Storage Volume	1500	(ft^3)

Per DWQ BMP design manual, the BMP must be designed to treat a volume at least as large as the volume calculated using the simple method

DWQ recommends 9" but requires ponding depth to be less then 12"

Catchment Area	109	BMP5, UT2
Pervious Area	109.00	
Impervious Area	0.00	

	Output
	Input

The Simple Method		
$R_V = 0.05 + 0.9 * I_A$		Step 1 in the Simple Method
R_V	0.05	Runoff coefficient (unitless)
I_A	0	Impervious fraction [impervious portion of drainage area (ac)/drainage area (ac)], (unitless)
$V = 3630 * R_D * R_V * A$		Step 2 in the Simple Method
V	19783.5	Volume of runoff that must be controlled for the design storm (cubic feet)
V	5.4500	Volume of runoff that must be controlled for the design storm (acre-in)
R_D	1.0	Design storm rainfall depth (in) (Typically 1.0" or 1.5")
A	109	Watershed area (ac)

1246175.4

***CN Method in this spreadsheet is for 2 CN areas only. The equations may need to be modified if using multiple CNs or use a composite pervious CN.

SCS Curve Number Method		
Q* = (P - 0.2S)^2 / (P + 0.8S)		
Q* (From Impervious)	0.02	Runoff depth (in)
P	1.0	Rainfall depth (in) (Typically 1.0" or 1.5")
S	3.56	Potential maximum retention after rainfall begins (in)
S = (1000 / CN) - 10	3.56	S is related to the soil and surface characteristics through the curve number (CN)
CN (Impervious)	73.8	Related to hydrologic soil group and ground cover. (Refer to DWQ Design Manual for CN Tables)
S = (1000 / CN) - 10	3.56	
CN (Pervious)	73.8	
Q* (From Pervious)	0.03	
P	1.00	
S	3.56	
Q*total	0.05	(in)
Soil Type	Pocalla loamy sand	http://websoilsurvey.nrcs.usda.gov/app/
Hydrologic Soil Group SCS (1986)	A	Refer to DWQ Design Manual after the soil series in the area of interest is identified

BMP Sizing Reqs		
V = A(Q*)	3.19	SCS Method Volume of Runoff (ac-in) Required Storage Volume
V	11571.82	SCS Method Volume of Runoff (cubic feet) Required Storage Volume
V	86563.21	SCS Method Volume of Runoff (gallons) Required Storage Volume
V	5.45	Simple Method Volume of Runoff (ac-in) Required Storage Volume
V	19783	Simple Method Volume of Runoff (cubic feet) Required Storage Volume
Required Ponding Depth	12.0	Depends on desired vegetation type and inundation time. Usually 6-12" (in)
Required BMP Surface Area	0.266	(ac) SCS Method
Required BMP Surface Area	11571.819	(ft^2) SCS Method
Required BMP Surface Area	0.454	(ac) Simple Method
Required BMP Surface Area	19783.500	(ft^2) Simple Method
Actual BMP Surface Area	0.344	(ac) Measured in Cadd, GIS or by hand.
Actual BMP Surface Area	15000	(ft^2)
Actual BMP Storage Volume	14999	(ft^3)

Per DWQ BMP design manual, the BMP must be designed to treat a volume at least as large as the volume calculated using the simple method

DWQ recommends 9" but requires ponding depth to be less then 12"

Catchment Area	110.6	BMP6, UT1
Pervious Area	110.60	
Impervious Area	0.00	

	Output
	Input

The Simple Method		
$R_V = 0.05 + 0.9 * I_A$	Step 1 in the Simple Method	
R_V	0.05	Runoff coefficient (unitless)
I_A	0	Impervious fraction [impervious portion of drainage area (ac)/drainage area (ac)], (unitless)
$V = 3630 * R_D * R_V * A$	Step 2 in the Simple Method	
V	20073.9	Volume of runoff that must be controlled for the design storm (cubic feet)
V	5.5300	Volume of runoff that must be controlled for the design storm (acre-in)
R_D	1.0	Design storm rainfall depth (in) (Typically 1.0" or 1.5")
A	110.6	Watershed area (ac)

1246175.4

***CN Method in this spreadsheet is for 2 CN areas only. The equations may need to be modified if using multiple CNs or use a composite pervious CN.

SCS Curve Number Method		
Q* = (P - 0.2S)^2 / (P + 0.8S)		
Q* (From Impervious)	0.01	Runoff depth (in)
P	1.0	Rainfall depth (in) (Typically 1.0" or 1.5")
S	4.10	Potential maximum retention after rainfall begins (in)
S = (1000 / CN) - 10	4.10	S is related to the soil and surface characteristics through the curve number (CN)
CN (Impervious)	70.9	Related to hydrologic soil group and ground cover. (Refer to DWQ Design Manual for CN Tables)
S = (1000 / CN) - 10	4.10	
CN (Pervious)	70.9	
Q* (From Pervious)	0.01	
P	1.00	
S	4.10	
Q*total	0.02	(in)
Soil Type	Pocalla loamy sand	http://websoilsurvey.nrcs.usda.gov/app/
Hydrologic Soil Group SCS (1986)	A	Refer to DWQ Design Manual after the soil series in the area of interest is identified

BMP Sizing Reqs		
V = A(Q*)	1.08	SCS Method Volume of Runoff (ac-in) Required Storage Volume
V	3923.20	SCS Method Volume of Runoff (cubic feet) Required Storage Volume
V	29347.54	SCS Method Volume of Runoff (gallons) Required Storage Volume
V	5.53	Simple Method Volume of Runoff (ac-in) Required Storage Volume
V	20074	Simple Method Volume of Runoff (cubic feet) Required Storage Volume
Required Ponding Depth	12.0	Depends on desired vegetation type and inundation time. Usually 6-12" (in)
Required BMP Surface Area	0.090	(ac) SCS Method
Required BMP Surface Area	3923.196	(ft^2) SCS Method
Required BMP Surface Area	0.461	(ac) Simple Method
Required BMP Surface Area	20073.900	(ft^2) Simple Method
Actual BMP Surface Area	0.275	(ac) Measured in Cadd, GIS or by hand.
Actual BMP Surface Area	12000	(ft^2)
Actual BMP Storage Volume	12000	(ft^3)

Per DWQ BMP design manual, the BMP must be designed to treat a volume at least as large as the volume calculated using the simple method

DWQ recommends 9" but requires ponding depth to be less then 12"

Catchment Area	98.45	BMP7, MS3
Pervious Area	98.45	
Impervious Area	0.00	

	Output
	Input

The Simple Method		
$R_V = 0.05 + 0.9 * I_A$		Step 1 in the Simple Method
R_V	0.05	Runoff coefficient (unitless)
I_A	0	Impervious fraction [impervious portion of drainage area (ac)/drainage area (ac)], (unitless)
$V = 3630 * R_D * R_V * A$		Step 2 in the Simple Method
V	17868.675	Volume of runoff that must be controlled for the design storm (cubic feet)
V	4.9225	Volume of runoff that must be controlled for the design storm (acre-in)
R_D	1.0	Design storm rainfall depth (in) (Typically 1.0" or 1.5")
A	98.45	Watershed area (ac)

1246175.4

***CN Method in this spreadsheet is for 2 CN areas only. The equations may need to be modified if using multiple CNs or use a composite pervious CN.

SCS Curve Number Method		
Q* = (P - 0.2S)^2 / (P + 0.8S)		
Q* (From Impervious)	0.00	Runoff depth (in)
P	1.0	Rainfall depth (in) (Typically 1.0" or 1.5")
S	4.32	Potential maximum retention after rainfall begins (in)
S = (1000 / CN) - 10	4.32	S is related to the soil and surface characteristics through the curve number (CN)
CN (Impervious)	69.8	Related to hydrologic soil group and ground cover. (Refer to DWQ Design Manual for CN Tables)
S = (1000 / CN) - 10	4.32	
CN (Pervious)	69.8	
Q* (From Pervious)	0.01	
P	1.00	
S	4.32	
Q*total	0.01	(in)
Soil Type	Pocalla loamy sand	http://websoilsurvey.nrcs.usda.gov/app/
Hydrologic Soil Group SCS (1986)	A	Refer to DWQ Design Manual after the soil series in the area of interest is identified

BMP Sizing Reqs		
V = A(Q*)	0.53	SCS Method Volume of Runoff (ac-in) Required Storage Volume
V	1909.62	SCS Method Volume of Runoff (cubic feet) Required Storage Volume
V	14284.96	SCS Method Volume of Runoff (gallons) Required Storage Volume
V	4.92	Simple Method Volume of Runoff (ac-in) Required Storage Volume
V	17869	Simple Method Volume of Runoff (cubic feet) Required Storage Volume
Required Ponding Depth	12.0	Depends on desired vegetation type and inundation time. Usually 6-12" (in)
Required BMP Surface Area	0.044	(ac) SCS Method
Required BMP Surface Area	1909.622	(ft^2) SCS Method
Required BMP Surface Area	0.410	(ac) Simple Method
Required BMP Surface Area	17868.675	(ft^2) Simple Method
Actual BMP Surface Area	0.230	(ac) Measured in Cadd, GIS or by hand.
Actual BMP Surface Area	10000	(ft^2)
Actual BMP Storage Volume	10000	(ft^3)

Per DWQ BMP design manual, the BMP must be designed to treat a volume at least as large as the volume calculated using the simple method

DWQ recommends 9" but requires ponding depth to be less then 12"


MS1– Straightened channel with bare banks 3/14/2018


MS1- Straightened channel (view southwest) 3/14/2018


MS2 – Straightened channel north of the WA (view north) 3/14/2018


MS2 – Culvert above UT2/UT3 confluence (view south) 3/14/2018


WA – Wetland on MS2 (view north) 3/14/2018


WA – Wetland on MS2 (view south east) 3/14/2018


MS3 – Downstream, incised channel 3/14/2018


MS3 – Downstream, exposed roots due to scour 3/14/2018

MS3 – Incised channel and bank with active scour 3/14/2018

MS3 – Exposed roots on stream meander 3/14/2018

UT1 – Upstream, incised/straightened channel (view east) 3/14/2018

UT2 – Incised/straightened channel (view west) 3/14/2018


UT2 – Straightened channel, no buffer (view west) 3/14/2018


UT2 – Straightened channel, no buffer (view east) 3/14/2018


Northern Reference Reach 3/14/2018


Northern Reference Reach 3/14/2018

Southern Reference Reach 1/8/2020

Southern Reference Reach 1/8/2020

Appendix 3 – Site Protection Instrument

WLS is in the process of obtaining a conservation easement from the current landowners for the project area. The easement deed and survey plat will be submitted to DMS and State Property Office (SPO) for approval and will be held by the State of North Carolina. Once recorded, the secured easement will allow WLS to proceed with the project development and protect the mitigation assets in perpetuity. The Table below includes the draft Site Protection Instrument information.

Table 3-1. Site Protection Instrument Information

Owner of Record N/F	PIN	County	Site Protection Instrument	Deed Book and Page Numbers	Acreage Protected
Edward Randolph Smith and Virginia Graves Smith	450000168662, 450000179525	Lenoir	Conservation Easement	Book: Page:	9.33
James Oliver Smith, Jr. and Rebecca Karen Aycock Smith	450000157485, 450000570958	Lenoir	Conservation Easement	Book: Page:	8.45
Paula Smith Hare and Edward Glenn Hare	450000362113	Lenoir	Conservation Easement	Book: Page:	5.65

Appendix 4 – Credit Release Schedule

All credit releases will be based on the total credit generated as reported in the approved final mitigation plan, unless there are major discrepancies and then a mitigation plan addendum will be submitted. Under no circumstances shall any mitigation project be debited until the necessary Department of the Army (DA) authorization has been received for its construction or the District Engineer (DE) has otherwise provided written approval for the project in the case where no DA authorization is required for construction of the mitigation project. The DE, in consultation with the NC Interagency Review Team (NCIRT), will determine if performance standards have been satisfied sufficiently to meet the requirements of the release schedules below. In cases where some performance standards have not been met, credits may still be released depending on the specifics of the case. Monitoring may be required to restart or be extended, depending on the extent to which the site fails to meet the specified performance standard. The release of project credits will be subject to the criteria described in the Tables below.

Table 4-1. Credit Release Schedule – Stream Credits

Credit Release Milestone	Credit Release Activity	Interim Release	Total Release
1	Site Establishment (includes all required criteria stated above)	0%	0%
2	Completion of all initial physical and biological improvements made pursuant to the Mitigation Plan	30%	30%
3	Year 1 monitoring report demonstrates that channels are stable and interim performance standards have been met	10%	40%
4	Year 2 monitoring report demonstrates that channels are stable and interim performance standards have been met	10%	50%
5	Year 3 monitoring report demonstrates that channels are stable and interim performance standards have been met	10%	60%
6*	Year 4 monitoring report demonstrates that channels are stable and interim performance standards have been met	5%	65% (75%**)
7	Year 5 monitoring report demonstrates that channels are stable and interim performance standards have been met	10%	75% (85%**)
8*	Year 6 monitoring report demonstrates that channels are stable and interim performance standards have been met	5%	80% (90%**)
9	Year 7 monitoring report demonstrates that channels are stable and performance standards have been met	10%	90% (100%**)

**Please note that vegetation and channel stability data may not be required with monitoring reports submitted during these monitoring years unless otherwise required by the Mitigation Plan or directed by the IRT.*
***10% reserve of credits to be held back until the bankfull event performance standard has been met.*

Initial Allocation of Released Credits

The initial allocation of released credits, as specified in the mitigation plan can be released by the NCDEQ DMS without prior written approval of the DE upon satisfactory completion of the following activities:

a. Approval of the Final Mitigation Plan
b. Recordation of the preservation mechanism, as well as a title opinion acceptable to the USACE covering the property.
c. Completion of project construction (the initial physical and biological improvements to the mitigation site) pursuant to the mitigation plan; Per the NCDEQ DMS Instrument, construction means that a mitigation site has been constructed in its entirety, to include planting, and an as-built report has been produced. As-built reports must be sealed by an engineer prior to project closeout, if appropriate but not prior to the initial allocation of released credits.
d. Receipt of necessary DA permit authorization or written DA approval for projects where DA permit issuance is not required.

Subsequent Credit Releases

All subsequent credit releases must be approved by the DE, in consultation with the IRT, based on a determination that required performance standards have been achieved. For stream projects a reserve of 10% of a site’s total stream credits shall be released after four bankfull events have occurred, in separate years, provided the channel is stable and all other performance standards are met. In the event that less than four bankfull events occur during the monitoring period, release of these reserve credits shall be at the discretion of the IRT. As projects approach milestones associated with credit release, DMS will submit a request for credit release to the DE along with documentation substantiating achievement of criteria required for release to occur. This documentation will be included with the annual monitoring report.

Appendix 5 – Financial Assurance

Pursuant to Section IV H and Appendix III of the NCDEQ DMS (formerly Ecosystem Enhancement Program) In-Lieu Fee Instrument dated July 28, 2010, the North Carolina Department of Environmental Quality (NCDEQ) has provided the USACE-Wilmington District with a formal commitment to fund projects to satisfy mitigation requirements assumed by NCDEQ DMS. This commitment provides financial assurance for all mitigation projects implemented by the program.

Appendix 6 – Maintenance Plan

The site will be monitored on a regular basis and a physical inspection of the site will take place at least once a year throughout the post-construction monitoring period until performance standards are met. These site inspections may identify site components and features that require routine maintenance. Routine maintenance should be expected most often in the first two years following site construction and may include the following:

Routine Maintenance Components Hornpipe Branch Tributaries Mitigation Project – NCDEQ DMS Project No. 100076	
Component/Feature	**Maintenance through project close-out**
Stream	Routine channel maintenance and repair activities may include modifying in-stream structures to prevent piping, securing loose coir matting, and supplemental installations of live stakes and other target vegetation along the project reaches. Areas of concentrated stormwater and floodplain flows that intercept the channel may also require maintenance to prevent bank failures and head-cutting. Stream maintenance activities will be documented and reported in annual monitoring reports.
Wetland	Routine wetland maintenance and repair activities may include supplemental installations of target vegetation within the wetland. Areas where stormwater and floodplain flows intercept the wetland may also require maintenance to prevent scour that adversely and persistently threatens wetland habitat or function.
Vegetation	Vegetation will be maintained to ensure the health and vigor of the targeted plant community. Routine vegetation maintenance and repair activities may include supplemental planting, pruning, and fertilizing. Exotic invasive plant species will be treated by mechanical and/or chemical methods. Any vegetation requiring herbicide application will be performed in accordance with NC Department of Agriculture (NCDA) rules and regulations. Vegetation maintenance activities will be documented and reported in annual monitoring reports.
Site Boundary	Site boundaries will be demarcated in the field to ensure clear distinction between the mitigation site and adjacent properties. Boundaries may be identified by fence, marker, bollard, post, or other means as allowed by site conditions and/or conservation easement. Boundary markers disturbed, damaged, or destroyed will be repaired and/or replaced on an as needed basis. Easement monitoring and staking/signage maintenance will continue in perpetuity as a stewardship activity.
Stream Crossing	The stream crossing(s) within the site may be maintained only as allowed by the recorded Conservation Easement, deed restrictions, rights of way, or corridor agreements. Crossings in easement breaks are the responsibility of the landowner to maintain.
Beaver Management	Routine maintenance and repair activities caused by beaver activity may include supplemental planting, pruning, and dewatering/dam removal. Beaver management will be implemented using accepted trapping and removal methods only within the recorded Conservation Easement.

Appendix 7 – DWR Stream Identification Forms

The streams at the project site were categorized into five reaches (MS1, MS2, MS3, UT1, UT2) totaling approximately 4,957 linear feet of existing streams. Reach breaks were based on drainage area breaks at confluences, changes in restoration approaches, and/or changes in stream status. Initial field evaluations were conducted by WLS staff in March 2018 and December 2019. During these site assessments, WLS classified project reaches MS1, MS2, MS3, and UT1 as perennial and UT2 as intermittent. The classifications were based on NCDWQ's Methodology for Identification of Intermittent and Perennial Streams and Their Origins, (v4.11, Effective Date: September 1, 2010) stream assessment protocols.

WLS submitted a preliminary jurisdictional determination (PJD) application package to the USACE in December 2019 and a USACE/DWR site visit was held on February 6th, 2020. Anthony Scarbraugh with DWR and Emily Thompson and Kyle Barnes with the USACE attended the site visit. The final PJD was issued on March 27th, 2020 and provided in Appendix 9. USACE and DWR classified project reaches, MS2 and MS3 as perennial, MS1 and UT1 as intermittent, and UT2 as ephemeral.

Table 7-1. Summary of Project Stream Status

Project Reach Designation	Existing Project Reach Length (ft)	NCDWQ Stream Classification Form Score	Watershed Drainage Area (acres)[1]	DWR Stream Determination[2]
MS1	1,493	23.75	183	Intermittent
MS2	774	33.0	222	Perennial
MS3	1,548	33.0	331	Perennial
UT1	498	21.5	46	Intermittent
UT2	644	17.25	32	Ephemeral

Note 1: Watershed drainage area was approximated based on topographic and LiDAR information and compared with USGS StreamStats at the downstream end of each reach.
Note 2: DWR stream classification based on on-site determination letter dated 2/17/20.

During the site visit, WLS and USACE/DWR visited the 'south reference reach' site to compare existing site conditions. After observing the adjacent headwater stream reference reach and reviewing the pre-restoration monitoring flow gauge data and geomorphic survey data (See Figure 11 Reference Reach Map and Appendix 2), both the USACE and DWR representatives agreed with the headwater steam restoration approach for reaches UT1 and UT2 and recommended installing an additional flow gauge along UT2 to document surface flow prior to restoration activities. This suggestion was also made during the NCIRT post-contract site visit held on June 15th, 2018 as documented in the meeting minutes (See Appendix 12). Accordingly, WLS will collect pre-and post-restoration data for reaches UT1 and UT2 to document surface flow hydrology and stream channel characteristics to support the jurisdictional determination and regulatory recommendations. The PJD and flow data will be provided in the final mitigation plan and issued with the NWP 27. Copies of the WLS stream ID forms and DWR stream determination letter with mapping are included herein.

ROY COOPER
Governor
MICHAEL S. REGAN
Secretary
S. DANIEL SMITH
Director

NORTH CAROLINA
Environmental Quality

February 17, 2020

Edward and Paula Smith
3532 Stanton Court
Graham, NC 27523

DWR #20-0048
LENOIR County

James O. Smith, Jr. and Rebecca Aycock Smith
662 P A Nobles Store Road
Deep Run, NC 28525

Edward R. and Virginia G. Smith
496 P A Nobles Stores Road
Deep Run, NC 28525

Subject: On-Site Determinations for Applicability to Water Quality Standards (15A NCAC 02B .0211)

Subject Property/ Project Name: Hornpipe Branch Tributaries Mitigation Bank

Address/Location: 1075 Sandy Foundation Rd, Deep Run

Stream(s) Evaluated: Unnamed Tributaries to Hornpipe Branch

Determination Date: 02/05/20 Staff: Anthony Scarbraugh

Determination Type:	
Buffer:	Stream:
☐ Neuse (15A NCAC 02B .0233) ☐ Tar-Pamlico (15A NCAC 02B .0259) ☐ Catawba (15A NCAC 02B .0243) ☐ Jordan (15A NCAC 02B .0267) (governmental and/or interjurisdictional projects) ☐ Randleman (15A NCAC 02B .0250) ☐ Goose Creek (15A NCAC 02B .0605-.0608)	☒ Intermittent/Perennial Determination

Stream	E/I/P*	Not Subject	Subject	Start@	Stop@	Soil Survey	USGS Topo
20-0048 A	I		X	Flag: 20-0048 A Begin	Flag: 20-0048 A I/P	X	X
20-0048 A	P		X	Flag: 20-0048 A I/P	Flag: 20-0048 A End	X	X
20-0048 B	E	X		Flag: 20-0048 B Begin	Flag: 20-0048 B End		X
20-0048 C	E	X		Flag: 20-0048 C Begin	Flag: 20-0048 C E/I	X	X
20-0048 C	I		X	Flag: 20-0048 C E/I	Flag: 20-0048 C End	X	X

**E/I/P/NSP = Ephemeral/Intermittent/Perennial/No Stream Present*

The Division of Water Resources (DWR) has determined that the streams listed above and included on the attached map have been located on the most recent published NRCS Soil Survey of LENOIR County, North Carolina and/or the most recent copy of the USGS Topographic map at a 1:24,000 scale and evaluated for applicability to the Water Quality Standards. Each stream that is checked "Not Subject" has been determined to not be at least intermittent or not present on the property. Streams that are checked "Subject" have been located on the property and possess characteristics that qualify them to be at least intermittent streams. There may be other streams or features located on the property that do not appear on the maps referenced above but may be considered jurisdictional according to the US Army Corps of Engineers and subject to the Clean Water Act.

This on-site determination shall expire five (5) years from the date of this letter. Landowners or affected parties that dispute a determination made by the DWR may request a determination by the Director. An appeal request must be made within sixty (60) calendar days of date of this letter to the Director in writing.

If sending via US Postal Service:
c/o *Paul Wojoski*
DWR – 401 & Buffer Permitting Unit
1617 Mail Service Center
Raleigh, NC 27699-1617

If sending via delivery service (UPS, FedEx, etc.):
c/o Paul Wojoski
DWR – 401 & Buffer Permitting Unit
512 N. Salisbury Street
Raleigh, NC 27604

This determination is final and binding as detailed above, unless an appeal is requested within sixty (60) days.

The project may require a Section 404/401 Permit for the proposed activity. Any inquiries regarding applicability to the Clean Water Act should be directed to the US Army Corps of Engineers Washington Regulatory Field Office at (910) 251-4629.

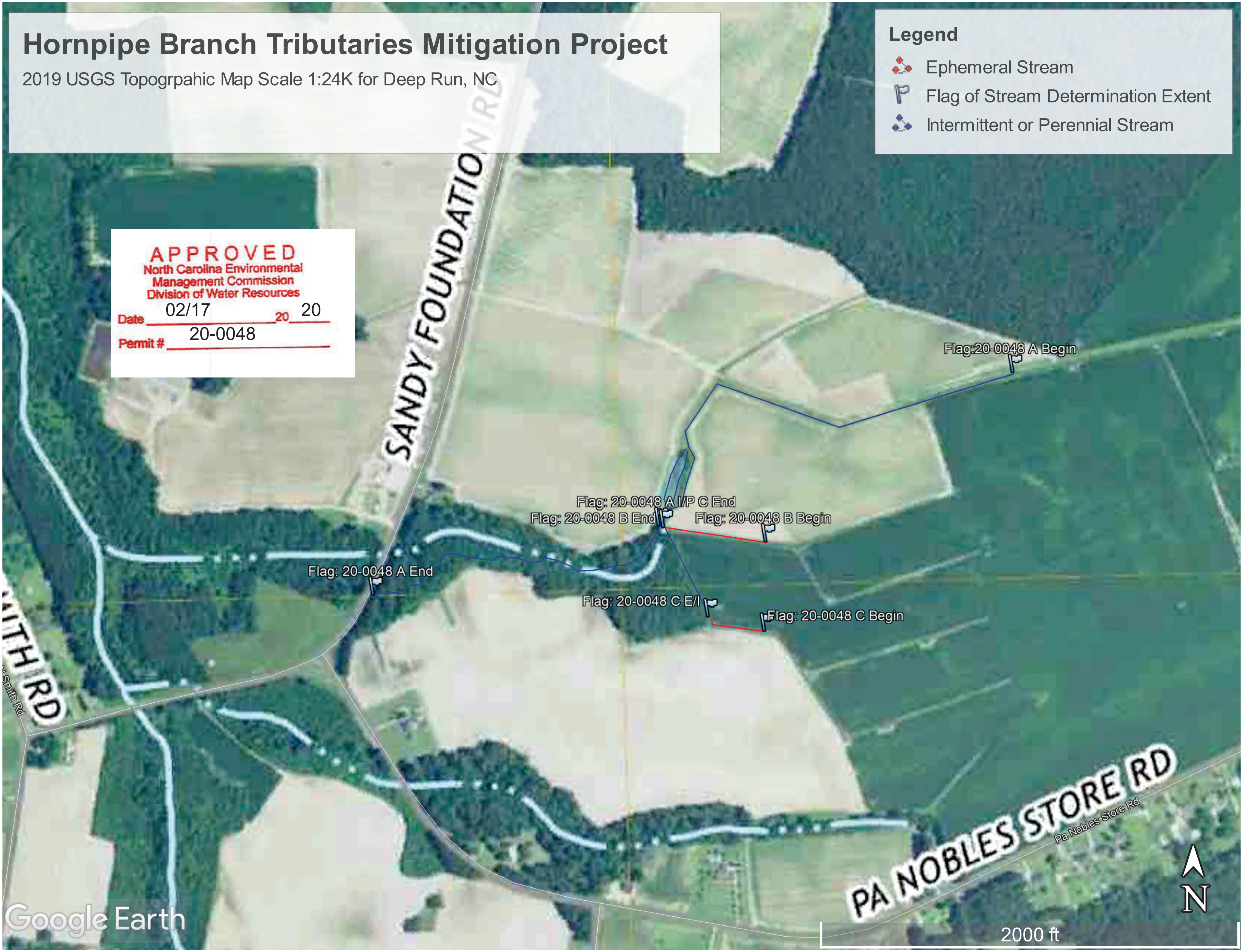
If you have questions regarding this determination, please feel free to contact Anthony Scarbraugh at (252) 948-3924.

Sincerely,

Robert Tankard

Robert Tankard, Assistant Regional Supervisor
Water Quality Regional Operations Section
Division of Water Resources, NCDEQ

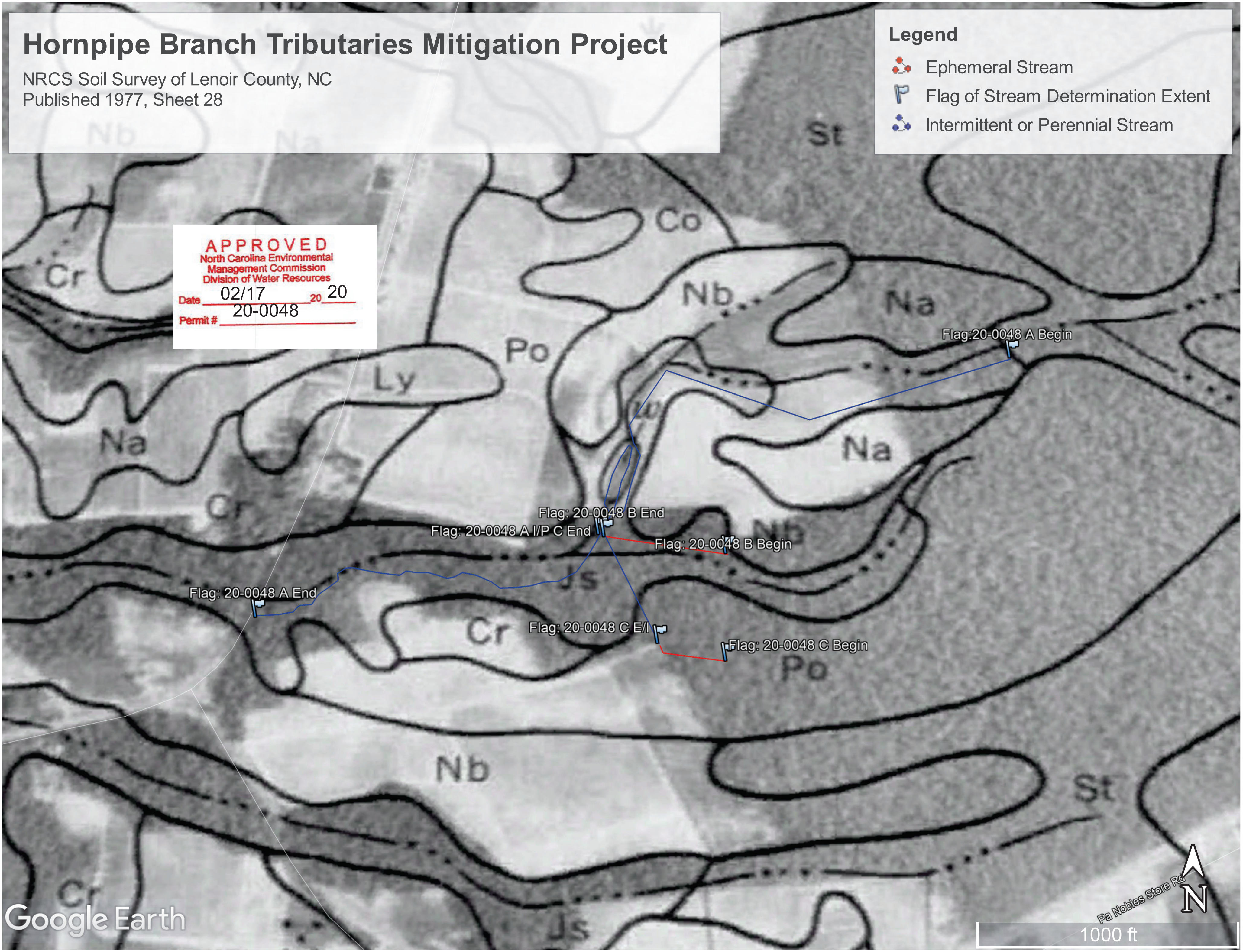
cc: LASERFICHE
Kyle Barnes, US Army Corps of Engineers Washington Regulatory Office
Emily Thompson, US Army Corps of Engineers Washington Regulatory Office
Mac Haupt, 401 & Buffer Permitting Unit (via email)
Erin Davis, 401 & Buffer Permitting Unit (via email)
Kyle Obermiller, Water & Land Solutions, LLC (via email)

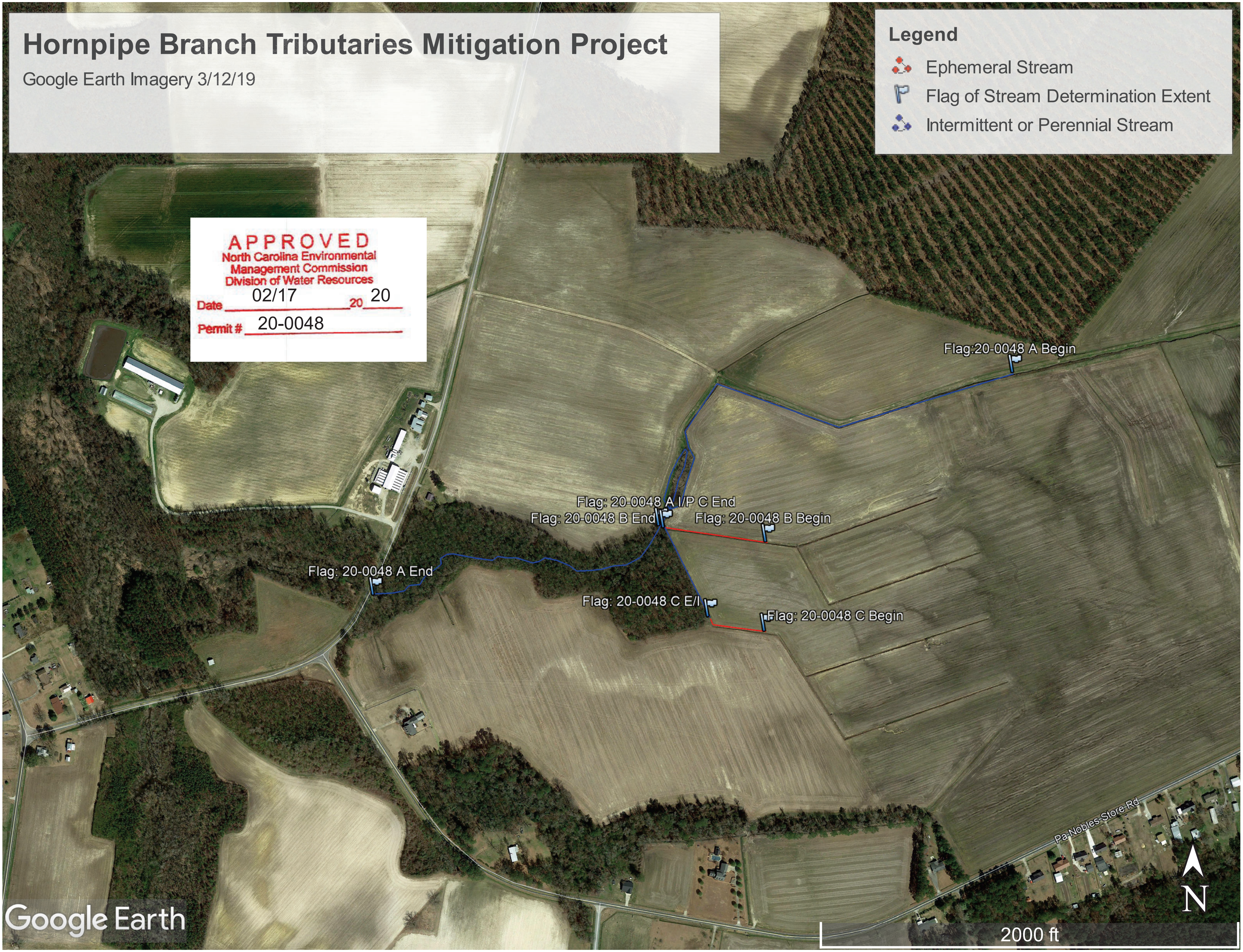


Hornpipe Branch Tributaries Mitigation Project
2019 USGS Topogrpahic Map Scale 1:24K for Deep Run, NC
Legend
Ephemeral Stream
Flag of Stream Determination Extent
Intermittent or Perennial Stream
APPROVED
North Carolina Environmental Management Commission
Division of Water Resources
Date 02/17 20 20
Permit # 20-0048
SANDY FOUNDATION RD
Flag:20-0048 A Begin
Flag: 20-0048 A I/P C End
Flag: 20-0048 B End
Flag: 20-0048 B Begin
Flag: 20-0048 A End
Flag: 20-0048 C E/I
Flag: 20-0048 C Begin
SMITH RD
PA NOBLES STORE RD
Pa Nobles Store Rd
N
2000 ft
Google Earth

Hornpipe Branch Tributaries Mitigation Project

NRCS Soil Survey of Lenoir County, NC
Published 1977, Sheet 28




Hornpipe Branch Tributaries Mitigation Project
Google Earth Imagery 3/12/19
Legend
Ephemeral Stream
Flag of Stream Determination Extent
Intermittent or Perennial Stream
APPROVED
North Carolina Environmental
Management Commission
Division of Water Resources
Date 02/17 20 20
Permit # 20-0048
Flag:20-0048 A Begin
Flag: 20-0048 A I/P C End
Flag: 20-0048 B End
Flag: 20-0048 B Begin
Flag: 20-0048 A End
Flag: 20-0048 C E/I
Flag: 20-0048 C Begin
Pa Nobles Store Rd
N
2000 ft
Google Earth

NC DWR Stream Identification Form Version 4.11

Date: 2/6/20	Project/Site: 20-0048A	Latitude: 35.135616
Evaluator: Anthony Scarbraugh	County: Lenoir	Longitude: 77.649702
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 23.75	**Stream Determination (circle one)** **Ephemeral Intermittent Perennial**	**Other** *e.g. Quad Name:* Deep Run

A. Geomorphology (Subtotal = 7.5)	Absent	Weak	Moderate	Strong
1[a]. Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 8)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

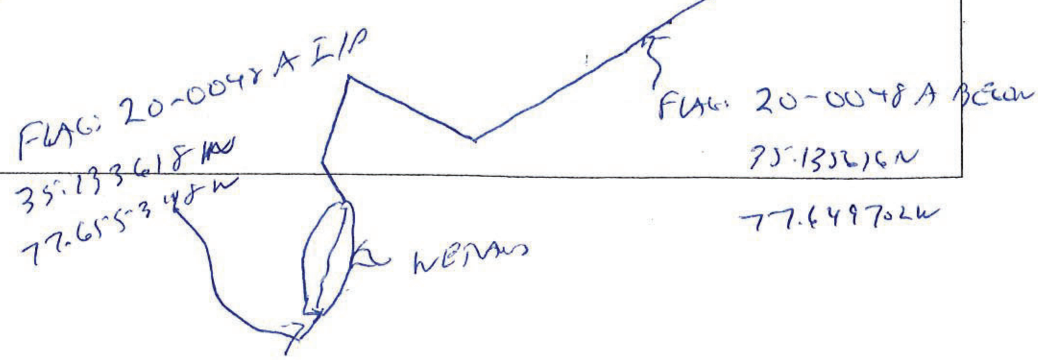
C. Biology (Subtotal = 8.25)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes:

Sketch:

Highly impacted with non uniform valley that has been ditched through upland area.



NC DWR Stream Identification Form Version 4.11

Date: 2/6/20	**Project/Site:** 20-0048 A	**Latitude:** 35.133618
Evaluator: Anthony Scarbrough	**County:** Lenoir	**Longitude:** 77.655348
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 33	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** *e.g. Quad Name:* Deep Run

A. Geomorphology (Subtotal = 17)	Absent	Weak	Moderate	Strong
1[a] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

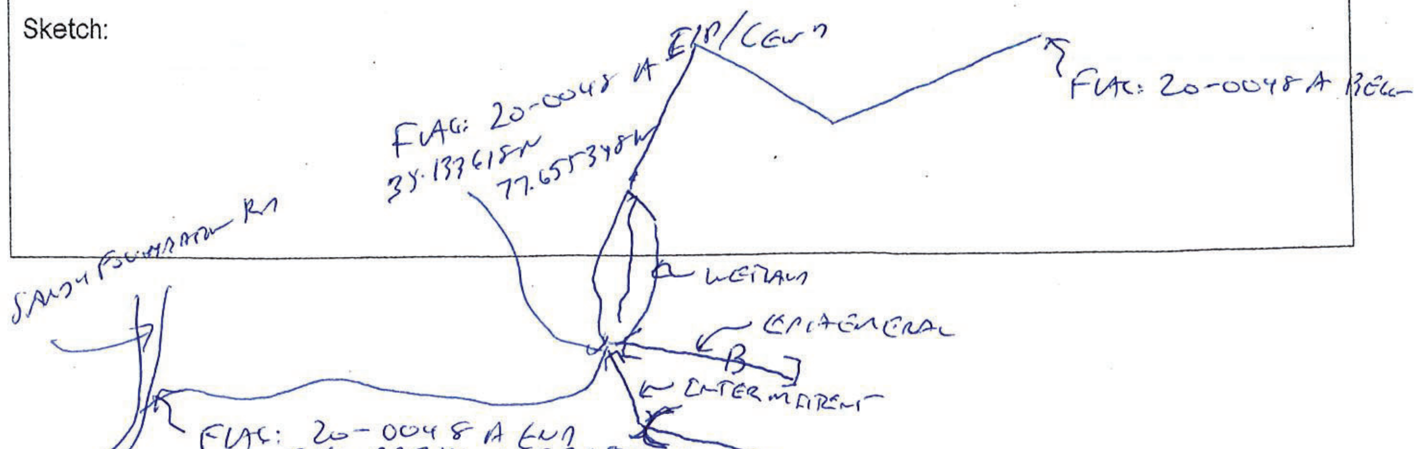
B. Hydrology (Subtotal = 9)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 7)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes:

Sketch:



NC DWR Stream Identification Form Version 4.11

Date: 2/6/20	Project/Site: 20-0048B	Latitude: 35.133592
Evaluator: ANTHONY SCARBRAUGH	County: LENOIR	Longitude: 77.655275
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 17.25	Stream Determination (circle one) Ephemeral Intermittent Perennial	Other *e.g. Quad Name:* DEEP RUN

A. Geomorphology (Subtotal = 4.5)	Absent	Weak	Moderate	Strong
1[a.] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 6)	Absent	Weak	Moderate	Strong
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 6.75)	Absent	Weak	Moderate	Strong
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

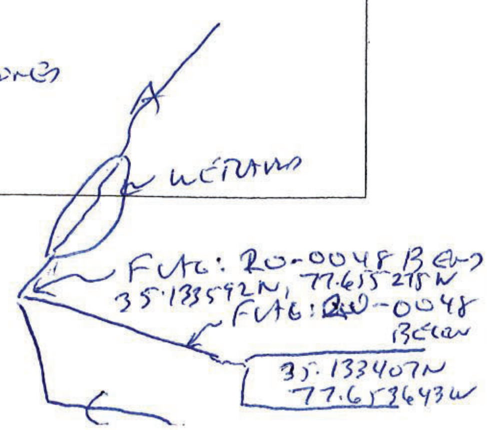
*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes:

Sketch:

JUNCUS PRESENT
SPP.

VERY LIMITED FLOW AND RECENTLY RAINED



NC DWR Stream Identification Form Version 4.11

Date: 2/6/20	**Project/Site:** 20-0048C	**Latitude:** 35.132241
Evaluator: Anthony Scarbrough	**County:** Lenoir	**Longitude:** 77.653663
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 16.75	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** *e.g. Quad Name:* Deep Run

A. Geomorphology (Subtotal = 4.5)	Absent	Weak	Moderate	Strong
1ª. Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

ª artificial ditches are not rated; see discussions in manual

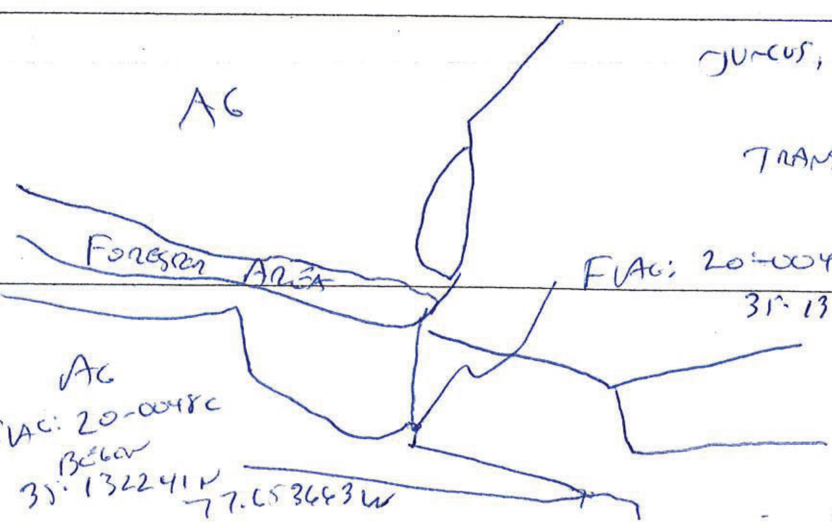
B. Hydrology (Subtotal = 5.5)				
12. Presence of Baseflow	0	1 →	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 6.75)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes:

Sketch:



JUNCUS, VEGETATION COVERING BOTTOM OF CHANNEL TRANSITION AT TREE LINE

FLAG: 20-0048C E/L 35.132430 N, 77.654563W

AG
FLAG: 20-0048C BEGIN 35.132241N 77.653663W

NC DWR Stream Identification Form Version 4.11

Date: 2/6/20	**Project/Site:** 20-0048C	**Latitude:** 35.132430
Evaluator: ANTHONY SEARBRAUCH	**County:** LENOIR	**Longitude:** 77.654563
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 21.5	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** *e.g. Quad Name:* DEEP RUN

A. Geomorphology (Subtotal = 8.5)	Absent	Weak	Moderate	Strong
1[a]. Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

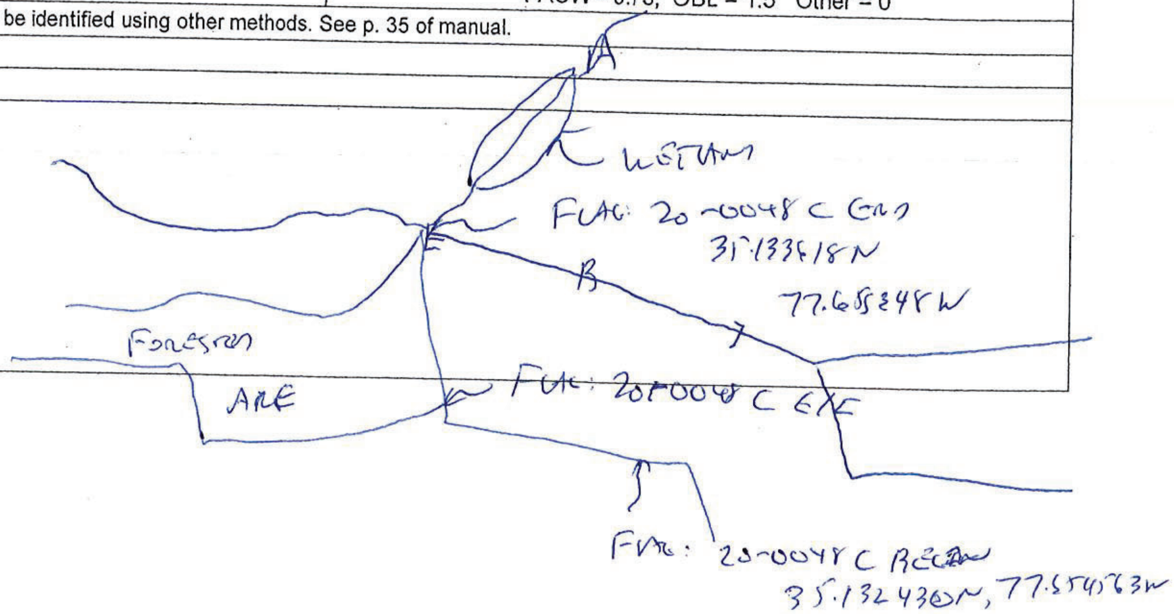
B. Hydrology (Subtotal = 9)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 4)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes:

Sketch:



MS-1

NC DWQ Stream Identification Form Version 4.11

Date: 12-4-2019	**Project/Site:** Hornpipe Mitigation Site	**Latitude:** 35.135488
Evaluator: WLS - K. Obermiller	**County:** Lenoir	**Longitude:** -77.65766
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 27.5*	**Stream Determination (circle one)** * **Ephemeral Intermittent Perennial**	**Other** *e.g. Quad Name:* Deep Run

A. Geomorphology (Subtotal = 10.0)	Absent	Weak	Moderate	Strong
1[a] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 9.0)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 8.5)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes: ditched stream, strong flow, green algae pres t

* likely perennial, highly impacted by d ch ng - 186 acre drainage area

Sketch:

MS - 2

NC DWQ Stream Identification Form Version 4.11

Date: 12-4-2019	**Project/Site:** Hornpipe Mitigation Site	**Latitude:** 35.13498
Evaluator: WLS - K. Obermiller	**County:** Lenoir	**Longitude:** -77.65485
Total Points: 29.5 *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30**	**Stream Determination (circle one)**☆ **Ephemeral Intermittent Perennial**	**Other** Deep Run *e.g. Quad Name:*

A. Geomorphology (Subtotal = 11.5)	Absent	Weak	Moderate	Strong
1[a] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 9.0)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 9.0)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes: fish, crayf sh ( ), a gae present
☆likely perennial, impac d by tch g

Sketch:

MS3

NC DWQ Stream Identification Form Version 4.11

Date: 3-14-2018	**Project/Site:** Hornpipe Mitigation Site	**Latitude:** 35.13335
Evaluator: Chris Sheats - WLS	**County:** Lenoir	**Longitude:** -77.65766
Total Points: 38.5 *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30**	**Stream Determination (circle one)** **Ephemeral Intermittent Perennial**	**Other** *e.g. Quad Name:* Deep Run

A. Geomorphology (Subtotal = 19.0)	Absent	Weak	Moderate	Strong
1[a]. Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

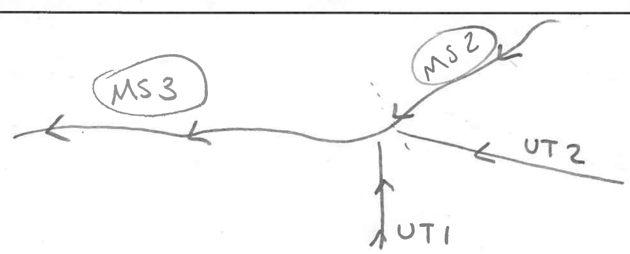
B. Hydrology (Subtotal = 9.5)	Absent	Weak	Moderate	Strong
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 10.0)	Absent	Weak	Moderate	Strong
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes: Cranefly larvae, odonate

Sketch:



NC DWQ Stream Identification Form Version 4.11

UT-1

Date: 3-14-2018	Project/Site: Hornpipe Mitigation	Latitude: 35.13266
Evaluator: Chris Sheats - WLS	County: Lenoir	Longitude: -77.65463
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 29.0	Stream Determination (circle one) Ephemeral Intermittent Perennial ☆	Other *e.g. Quad Name:* Deep Run

A. Geomorphology (Subtotal = 8.5)	Absent	Weak	Moderate	Strong
1[a.] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

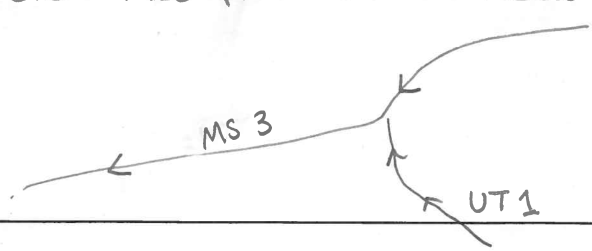
B. Hydrology (Subtotal = 8.5)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 12.0)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes: Murdannia keisak, crayfish, chironom, aquatic oms, odonate larvae

Sketch: ☆ Determined perennial field



NC DWQ Stream Identification Form Version 4.11

UT2

Date: 12-4-2019	**Project/Site:** Hornpipe Mitigation Site	**Latitude:** 35.13345
Evaluator: WLS- K. Obermiller	**County:** Lenoir	**Longitude:** -77.65406
Total Points: 22.0 *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30**	**Stream Determination (circle one)** **Ephemeral Intermittent Perennial**	**Other** Deep Run *e.g. Quad Name:*

A. Geomorphology (Subtotal = 7.0)	Absent	Weak	Moderate	Strong
1[a] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 9.0)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 6.0)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes: Algae present, stream ditched

Sketch:

Appendix 8 – USACE District Assessment Methods/Forms

NCSAM
NCWAM

NC SAM FIELD ASSESSMENT FORM
Accompanies User Manual Version 2.1

USACE AID #: NCDWR #:

INSTRUCTIONS: Attach a sketch of the assessment area and photographs. Attach a copy of the USGS 7.5-minute topographic quadrangle, and circle the location of the stream reach under evaluation. If multiple stream reaches will be evaluated on the same property, identify and number all reaches on the attached map, and include a separate form for each reach. See the NC SAM User Manual for detailed descriptions and explanations of requested information. Record in the "Notes/Sketch" section if supplementary measurements were performed. See the NC SAM User Manual for examples of additional measurements that may be relevant.

NOTE EVIDENCE OF STRESSORS AFFECTING THE ASSESSMENT AREA (do not need to be within the assessment area).

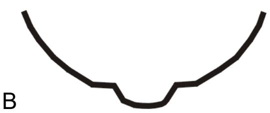
PROJECT/SITE INFORMATION:
1. Project name (if any): Hornpipe Branch Tributaries MS1
2. Date of evaluation: 12-4-2019
3. Applicant/owner name: Water & Land Solutions
4. Assessor name/organization: Kyle Obermiller - WLS
5. County: Lenoir
6. Nearest named water body on USGS 7.5-minute quad: Hornpipe Branch
7. River basin: Neuse
8. Site coordinates (decimal degrees, at lower end of assessment reach): 35.13538, -77.65074

STREAM INFORMATION: (depth and width can be approximations)
9. Site number (show on attached map): MS1
10. Length of assessment reach evaluated (feet): 1409
11. Channel depth from bed (in riffle, if present) to top of bank (feet): 3 ☐Unable to assess channel depth.
12. Channel width at top of bank (feet): 5
13. Is assessment reach a swamp steam? ☐Yes ☒No
14. Feature type: ☒Perennial flow ☐Intermittent flow ☐Tidal Marsh Stream

STREAM CATEGORY INFORMATION:
15. NC SAM Zone: ☐ Mountains (M) ☐ Piedmont (P) ☒ Inner Coastal Plain (I) ☐ Outer Coastal Plain (O)

16. Estimated geomorphic valley shape (**skip for Tidal Marsh Stream**):

☒A 
(more sinuous stream, flatter valley slope)

☐B 
(less sinuous stream, steeper valley slope)

17. Watershed size: (**skip for Tidal Marsh Stream**) ☐Size 1 (< 0.1 mi^2) ☒Size 2 (0.1 to < 0.5 mi^2) ☐Size 3 (0.5 to < 5 mi^2) ☐Size 4 (≥ 5 mi^2)

ADDITIONAL INFORMATION:
18. Were regulatory considerations evaluated? ☒Yes ☐No If Yes, check all that apply to the assessment area.

☐Section 10 water ☐Classified Trout Waters ☐Water Supply Watershed (☐I ☐II ☐III ☐IV ☐V)
☐Essential Fish Habitat ☐Primary Nursery Area ☐ High Quality Waters/Outstanding Resource Waters
☐Publicly owned property ☐NCDWR Riparian buffer rule in effect ☐Nutrient Sensitive Waters
☐Anadromous fish ☐303(d) List ☐CAMA Area of Environmental Concern (AEC)
☐Documented presence of a federal and/or state listed protected species within the assessment area.
List species:
☐Designated Critical Habitat (list species)

19. Are additional stream information/supplementary measurements included in "Notes/Sketch" section or attached? ☐Yes ☒No

1. **Channel Water – assessment reach metric (skip for Size 1 streams and Tidal Marsh Streams)**
   - ☒A Water throughout assessment reach.
   - ☐B No flow, water in pools only.
   - ☐C No water in assessment reach.

2. **Evidence of Flow Restriction – assessment reach metric**
   - ☐A At least 10% of assessment reach in-stream habitat or riffle-pool sequence is severely affected by a flow restriction or fill to the point of obstructing flow or a channel choked with aquatic macrophytes or ponded water or impoundment on flood or ebb within the assessment reach (examples: undersized or perched culverts, causeways that constrict the channel, tidal gates, debris jams, beaver dams).
   - ☒B Not A

3. **Feature Pattern – assessment reach metric**
   - ☒A A majority of the assessment reach has altered pattern (examples: straightening, modification above or below culvert).
   - ☐B Not A

4. **Feature Longitudinal Profile – assessment reach metric**
   - ☒A Majority of assessment reach has a substantially altered stream profile (examples: channel down-cutting, existing damming, over widening, active aggradation, dredging, and excavation where appropriate channel profile has not reformed from any of these disturbances).
   - ☐B Not A

5. **Signs of Active Instability – assessment reach metric**
   Consider only current instability, not past events from which the stream has currently recovered. Examples of instability include active bank failure, active channel down-cutting (head-cut), active widening, and artificial hardening (such as concrete, gabion, rip-rap).
   - ☐A < 10% of channel unstable
   - ☐B 10 to 25% of channel unstable
   - ☒C > 25% of channel unstable

6. **Streamside Area Interaction – streamside area metric**
Consider for the Left Bank (LB) and the Right Bank (RB).

LB	RB	
☐A	☐A	Little or no evidence of conditions that adversely affect reference interaction
☐B	☐B	Moderate evidence of conditions (examples: berms, levees, down-cutting, aggradation, dredging) that adversely affect reference interaction (examples: limited streamside area access, disruption of flood flows through streamside area, leaky or intermittent bulkheads, causeways with floodplain constriction, minor ditching [including mosquito ditching])
☒C	☒C	Extensive evidence of conditions that adversely affect reference interaction (little to no floodplain/intertidal zone access [examples: causeways with floodplain and channel constriction, bulkheads, retaining walls, fill, stream incision, disruption of flood flows through streamside area] or too much floodplain/intertidal zone access [examples: impoundments, intensive mosquito ditching]) or floodplain/intertidal zone unnaturally absent or assessment reach is a man-made feature on an interstream divide

7. **Water Quality Stressors – assessment reach/intertidal zone metric**
Check all that apply.
☐A Discolored water in stream or intertidal zone (milky white, blue, unnatural water discoloration, oil sheen, stream foam)
☐B Excessive sedimentation (burying of stream features or intertidal zone)
☒C Noticeable evidence of pollutant discharges entering the assessment reach and causing a water quality problem
☐D Odor (not including natural sulfide odors)
☐E Current published or collected data indicating degraded water quality in the assessment reach. Cite source in “Notes/Sketch” section.
☐F Livestock with access to stream or intertidal zone
☐G Excessive algae in stream or intertidal zone
☐H Degraded marsh vegetation in the intertidal zone (removal, burning, regular mowing, destruction, etc)
☒I Other: ____________________ (explain in “Notes/Sketch” section)
☐J Little to no stressors

8. **Recent Weather – watershed metric (skip for Tidal Marsh Streams)**
For Size 1 or 2 streams, D1 drought or higher is considered a drought; for Size 3 or 4 streams, D2 drought or higher is considered a drought.
☐A Drought conditions and no rainfall or rainfall not exceeding 1 inch within the last 48 hours
☐B Drought conditions and rainfall exceeding 1 inch within the last 48 hours
☒C No drought conditions

9. **Large or Dangerous Stream – assessment reach metric**
☐Yes ☒No Is stream is too large or dangerous to assess? If Yes, skip to Metric 13 (Streamside Area Ground Surface Condition).

10. **Natural In-stream Habitat Types – assessment reach metric**
10a. ☒Yes ☐No Degraded in-stream habitat over majority of the assessment reach (examples of stressors include excessive sedimentation, mining, excavation, in-stream hardening [for example, rip-rap], recent dredging, and snagging) **(evaluate for Size 4 Coastal Plain streams only, then skip to Metric 12)**

10b. **Check all that occur** (occurs if > 5% coverage of assessment reach) **(skip for Size 4 Coastal Plain streams)**
☐A Multiple aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
☐B Multiple sticks and/or leaf packs and/or emergent vegetation
☐C Multiple snags and logs (including lap trees)
☐D 5% undercut banks and/or root mats and/or roots in banks extend to the normal wetted perimeter
☒E Little or no habitat

Check for Tidal Marsh Streams Only
☐F 5% oysters or other natural hard bottoms
☐G Submerged aquatic vegetation
☐H Low-tide refugia (pools)
☐I Sand bottom
☐J 5% vertical bank along the marsh
☐K Little or no habitat

*********************************REMAINING QUESTIONS ARE NOT APPLICABLE FOR TIDAL MARSH STREAMS****************************

11. **Bedform and Substrate – assessment reach metric (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**

11a. ☒Yes ☐No Is assessment reach in a natural sand-bed stream? **(skip for Coastal Plain streams)**

11b. Bedform evaluated. **Check the appropriate box(es).**
☐A Riffle-run section **(evaluate 11c)**
☐B Pool-glide section **(evaluate 11d)**
☒C Natural bedform absent **(skip to Metric 12, Aquatic Life)**

11c. In riffle sections, check all that occur below the normal wetted perimeter of the assessment reach – whether or not submerged. **Check at least one box in each row (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**. Not Present (NP) = absent, Rare (R) = present but ≤ 10%, Common (C) = > 10-40%, Abundant (A) = > 40-70%, Predominant (P) = > 70%. Cumulative percentages should not exceed 100% for each assessment reach.

NP	R	C	A	P	
☐	☐	☐	☐	☐	Bedrock/saprolite
☐	☐	☐	☐	☐	Boulder (256 – 4096 mm)
☐	☐	☐	☐	☐	Cobble (64 – 256 mm)
☐	☐	☐	☐	☐	Gravel (2 – 64 mm)
☐	☐	☐	☐	☐	Sand (.062 – 2 mm)
☐	☐	☐	☐	☐	Silt/clay (< 0.062 mm)
☐	☐	☐	☐	☐	Detritus
☐	☐	☐	☐	☐	Artificial (rip-rap, concrete, etc.)

11d. ☐Yes ☐No Are pools filled with sediment? (**skip for Size 4 Coastal Plain streams and Tidal Marsh Streams**)

12. Aquatic Life – assessment reach metric (skip for Tidal Marsh Streams)

12a. ☒Yes ☐No Was an in-stream aquatic life assessment performed as described in the User Manual?
If No, select one of the following reasons and skip to Metric 13. ☐No Water ☐Other: ____________________

12b. ☒Yes ☐No Are aquatic organisms present in the assessment reach (look in riffles, pools, then snags)? If Yes, check all that apply. If No, skip to Metric 13.

1	>1	Numbers over columns refer to "individuals" for Size 1 and 2 streams and "taxa" for Size 3 and 4 streams.
☐	☐	Adult frogs
☐	☐	Aquatic reptiles
☐	☐	Aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
☐	☐	Beetles
☐	☐	Caddisfly larvae (T)
☐	☐	Asian clam (*Corbicula*)
☐	☐	Crustacean (isopod/amphipod/crayfish/shrimp)
☐	☐	Damselfly and dragonfly larvae
☐	☐	Dipterans
☐	☐	Mayfly larvae (E)
☐	☐	Megaloptera (alderfly, fishfly, dobsonfly larvae)
☐	☐	Midges/mosquito larvae
☐	☐	Mosquito fish (*Gambusia*) or mud minnows (*Umbra pygmaea)*
☐	☐	Mussels/Clams (not *Corbicula*)
☐	☒	Other fish
☐	☐	Salamanders/tadpoles
☐	☐	Snails
☐	☐	Stonefly larvae (P)
☐	☐	Tipulid larvae
☐	☐	Worms/leeches

13. Streamside Area Ground Surface Condition – streamside area metric (skip for Tidal Marsh Streams and B valley types)
Consider for the Left Bank (LB) and the Right Bank (RB). Consider storage capacity with regard to both overbank flow and upland runoff.

LB	RB	
☐A	☐A	Little or no alteration to water storage capacity over a majority of the streamside area
☐B	☐B	Moderate alteration to water storage capacity over a majority of the streamside area
☒C	☒C	Severe alteration to water storage capacity over a majority of the streamside area (examples: ditches, fill, soil compaction, livestock disturbance, buildings, man-made levees, drainage pipes)

14. Streamside Area Water Storage – streamside area metric (skip for Size 1 streams, Tidal Marsh Streams, and B valley types)
Consider for the Left Bank (LB) and the Right Bank (RB) of the streamside area.

LB	RB	
☐A	☐A	Majority of streamside area with depressions able to pond water ≥ 6 inches deep
☐B	☐B	Majority of streamside area with depressions able to pond water 3 to 6 inches deep
☒C	☒C	Majority of streamside area with depressions able to pond water < 3 inches deep

15. Wetland Presence – streamside area metric (skip for Tidal Marsh Streams)
Consider for the Left Bank (LB) and the Right Bank (RB). Do not consider wetlands outside of the streamside area or within the normal wetted perimeter of assessment reach.

LB	RB	
☐Y	☐Y	Are wetlands present in the streamside area?
☒N	☒N	

16. Baseflow Contributors – assessment reach metric (skip for Size 4 streams and Tidal Marsh Streams)
Check all contributors within the assessment reach or within view of <u>and</u> draining to the assessment reach.

- ☒A Streams and/or springs (jurisdictional discharges)
- ☐B Ponds (include wet detention basins; do not include sediment basins or dry detention basins)
- ☐C Obstruction passing flow during low-flow periods within the assessment area (beaver dam, leaky dam, bottom-release dam, weir)
- ☐D Evidence of bank seepage or sweating (iron in water indicates seepage)
- ☐E Stream bed or bank soil reduced (dig through deposited sediment if present)
- ☐F None of the above

17. Baseflow Detractors – assessment area metric (skip for Tidal Marsh Streams)
Check all that apply.

- ☐A Evidence of substantial water withdrawals from the assessment reach (includes areas excavated for pump installation)
- ☐B Obstruction not passing flow during low-flow periods affecting the assessment reach (ex: watertight dam, sediment deposit)
- ☐C Urban stream (≥ 24% impervious surface for watershed)
- ☐D Evidence that the streamside area has been modified resulting in accelerated drainage into the assessment reach
- ☐E Assessment reach relocated to valley edge
- ☒F None of the above

18. Shading – assessment reach metric (skip for Tidal Marsh Streams)
Consider aspect. Consider "leaf-on" condition.

- ☐A Stream shading is appropriate for stream category (may include gaps associated with natural processes)
- ☐B Degraded (example: scattered trees)
- ☒C Stream shading is gone or largely absent

19. **Buffer Width – streamside area metric (skip for Tidal Marsh Streams)**
Consider "vegetated buffer" and "wooded buffer" separately for left bank (LB) and right bank (RB) starting at the top of bank out to the first break.

Vegetated LB	Vegetated RB	Wooded LB	Wooded RB	
☐A	☐A	☐A	☐A	≥ 100 feet wide <u>or</u> extends to the edge of the watershed
☐B	☐B	☐B	☐B	From 50 to < 100 feet wide
☐C	☐C	☐C	☐C	From 30 to < 50 feet wide
☐D	☐D	☐D	☐D	From 10 to < 30 feet wide
☒E	☒E	☒E	☒E	< 10 feet wide <u>or</u> no trees

20. **Buffer Structure – streamside area metric (skip for Tidal Marsh Streams)**
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Vegetated" Buffer Width).

LB	RB	
☐A	☐A	Mature forest
☐B	☐B	Non-mature woody vegetation <u>or</u> modified vegetation structure
☐C	☐C	Herbaceous vegetation with or without a strip of trees < 10 feet wide
☐D	☐D	Maintained shrubs
☒E	☒E	Little or no vegetation

21. **Buffer Stressors – streamside area metric (skip for Tidal Marsh Streams)**
Check all appropriate boxes for left bank (LB) and right bank (RB). Indicate if listed stressor abuts stream (Abuts), does not abut but is within 30 feet of stream (< 30 feet), or is between 30 to 50 feet of stream (30-50 feet).
If none of the following stressors occurs on either bank, check here and skip to Metric 22: ☐

Abuts LB	Abuts RB	< 30 feet LB	< 30 feet RB	30-50 feet LB	30-50 feet RB	
☒A	☒A	☐A	☐A	☐A	☐A	Row crops
☐B	☐B	☐B	☐B	☐B	☐B	Maintained turf
☐C	☐C	☐C	☐C	☐C	☐C	Pasture (no livestock)/commercial horticulture
☐D	☐D	☐D	☐D	☐D	☐D	Pasture (active livestock use)

22. **Stem Density – streamside area metric (skip for Tidal Marsh Streams)**
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Wooded" Buffer Width).

LB	RB	
☐A	☐A	Medium to high stem density
☐B	☐B	Low stem density
☒C	☒C	No wooded riparian buffer <u>or</u> predominantly herbaceous species <u>or</u> bare ground

23. **Continuity of Vegetated Buffer – streamside area metric (skip for Tidal Marsh Streams)**
Consider whether vegetated buffer is continuous along stream (parallel). Breaks are areas lacking vegetation > 10 feet wide.

LB	RB	
☐A	☐A	The total length of buffer breaks is < 25 percent.
☐B	☐B	The total length of buffer breaks is between 25 and 50 percent.
☒C	☒C	The total length of buffer breaks is > 50 percent.

24. **Vegetative Composition – streamside area metric (skip for Tidal Marsh Streams)**
Evaluate the dominant vegetation within 100 feet of each bank or to the edge of the watershed (whichever comes first) as it contributes to assessment reach habitat.

LB	RB	
☐A	☐A	Vegetation is close to undisturbed in species present and their proportions. Lower strata composed of native species, with non-native invasive species absent or sparse.
☐B	☐B	Vegetation indicates disturbance in terms of species diversity or proportions, but is still largely composed of native species. This may include communities of weedy native species that develop after clear-cutting or clearing <u>or</u> communities with non-native invasive species present, but not dominant, over a large portion of the expected strata <u>or</u> communities missing understory but retaining canopy trees.
☒C	☒C	Vegetation is severely disturbed in terms of species diversity or proportions. Mature canopy is absent <u>or</u> communities with non-native invasive species dominant over a large portion of expected strata <u>or</u> communities composed of planted stands of non-characteristic species <u>or</u> communities inappropriately composed of a single species <u>or</u> no vegetation.

25. **Conductivity – assessment reach metric (skip for all Coastal Plain streams)**
25a. ☐Yes ☒No Was conductivity measurement recorded?
If No, select one of the following reasons. ☐No Water ☐Other: ______________________________

25b. Check the box corresponding to the conductivity measurement (units of microsiemens per centimeter).
☐A < 46 ☐B 46 to < 67 ☐C 67 to < 79 ☐D 79 to < 230 ☐E ≥ 230

Notes/Sketch:

Draft NC SAM Stream Rating Sheet
Accompanies User Manual Version 2.1

Stream Site Name	Hornpipe Branch Tributaries MS1	Date of Assessment	12-4-2019
Stream Category	Ia2	Assessor Name/Organization	Kyle Obermiller - WLS

Notes of Field Assessment Form (Y/N)	NO
Presence of regulatory considerations (Y/N)	NO
Additional stream information/supplementary measurements included (Y/N)	NO
NC SAM feature type (perennial, intermittent, Tidal Marsh Stream)	Perennial

Function Class Rating Summary	**USACE/ All Streams**	**NCDWR Intermittent**
(1) Hydrology	**LOW**	
(2) Baseflow	**HIGH**	
(2) Flood Flow	**LOW**	
(3) Streamside Area Attenuation	**LOW**	
(4) Floodplain Access	**LOW**	
(4) Wooded Riparian Buffer	**LOW**	
(4) Microtopography	**LOW**	
(3) Stream Stability	**LOW**	
(4) Channel Stability	**LOW**	
(4) Sediment Transport	**LOW**	
(4) Stream Geomorphology	**LOW**	
(2) Stream/Intertidal Zone Interaction	NA	
(2) Longitudinal Tidal Flow	NA	
(2) Tidal Marsh Stream Stability	NA	
(3) Tidal Marsh Channel Stability	NA	
(3) Tidal Marsh Stream Geomorphology	NA	
(1) Water Quality	**LOW**	
(2) Baseflow	**HIGH**	
(2) Streamside Area Vegetation	**LOW**	
(3) Upland Pollutant Filtration	**LOW**	
(3) Thermoregulation	**LOW**	
(2) Indicators of Stressors	**YES**	
(2) Aquatic Life Tolerance	**LOW**	
(2) Intertidal Zone Filtration	NA	
(1) Habitat	**LOW**	
(2) In-stream Habitat	**LOW**	
(3) Baseflow	**HIGH**	
(3) Substrate	**LOW**	
(3) Stream Stability	**LOW**	
(3) In-stream Habitat	**LOW**	
(2) Stream-side Habitat	**LOW**	
(3) Stream-side Habitat	**LOW**	
(3) Thermoregulation	**LOW**	
(2) Tidal Marsh In-stream Habitat	NA	
(3) Flow Restriction	NA	
(3) Tidal Marsh Stream Stability	NA	
(4) Tidal Marsh Channel Stability	NA	
(4) Tidal Marsh Stream Geomorphology	NA	
(3) Tidal Marsh In-stream Habitat	NA	
(2) Intertidal Zone	NA	
Overall	**LOW**	

NC SAM FIELD ASSESSMENT FORM
Accompanies User Manual Version 2.1

USACE AID #: NCDWR #:

INSTRUCTIONS: Attach a sketch of the assessment area and photographs. Attach a copy of the USGS 7.5-minute topographic quadrangle, and circle the location of the stream reach under evaluation. If multiple stream reaches will be evaluated on the same property, identify and number all reaches on the attached map, and include a separate form for each reach. See the NC SAM User Manual for detailed descriptions and explanations of requested information. Record in the "Notes/Sketch" section if supplementary measurements were performed. See the NC SAM User Manual for examples of additional measurements that may be relevant.

NOTE EVIDENCE OF STRESSORS AFFECTING THE ASSESSMENT AREA (do not need to be within the assessment area).

PROJECT/SITE INFORMATION:

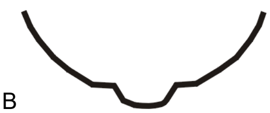
1. Project name (if any): Hornpipe Branch Tributaries MS2 2. Date of evaluation: 12-4-2019
3. Applicant/owner name: Water & Land Solutions 4. Assessor name/organization: Kyle Obermiller - WLS
5. County: Lenoir 6. Nearest named water body
7. River basin: Neuse on USGS 7.5-minute quad: Hornpipe Branch
8. Site coordinates (decimal degrees, at lower end of assessment reach): 35.13488, -77.65495

STREAM INFORMATION: (depth and width can be approximations)

9. Site number (show on attached map): MS2 10. Length of assessment reach evaluated (feet): 890
11. Channel depth from bed (in riffle, if present) to top of bank (feet): 4 ☐Unable to assess channel depth.
12. Channel width at top of bank (feet): 6 13. Is assessment reach a swamp steam? ☐Yes ☒No
14. Feature type: ☒Perennial flow ☐Intermittent flow ☐Tidal Marsh Stream

STREAM CATEGORY INFORMATION:

15. NC SAM Zone: ☐ Mountains (M) ☐ Piedmont (P) ☒ Inner Coastal Plain (I) ☐ Outer Coastal Plain (O)

16. Estimated geomorphic valley shape (**skip for Tidal Marsh Stream**):
☒A  (more sinuous stream, flatter valley slope)
☐B  (less sinuous stream, steeper valley slope)

17. Watershed size: (**skip for Tidal Marsh Stream**) ☐Size 1 (< 0.1 mi^2) ☒Size 2 (0.1 to < 0.5 mi^2) ☐Size 3 (0.5 to < 5 mi^2) ☐Size 4 (≥ 5 mi^2)

ADDITIONAL INFORMATION:

18. Were regulatory considerations evaluated? ☒Yes ☐No If Yes, check all that apply to the assessment area.
- ☐Section 10 water ☐Classified Trout Waters ☐Water Supply Watershed (☐I ☐II ☐III ☐IV ☐V)
- ☐Essential Fish Habitat ☐Primary Nursery Area ☐ High Quality Waters/Outstanding Resource Waters
- ☐Publicly owned property ☐NCDWR Riparian buffer rule in effect ☐Nutrient Sensitive Waters
- ☐Anadromous fish ☐303(d) List ☐CAMA Area of Environmental Concern (AEC)
- ☐Documented presence of a federal and/or state listed protected species within the assessment area.
  List species:
- ☐Designated Critical Habitat (list species)

19. Are additional stream information/supplementary measurements included in "Notes/Sketch" section or attached? ☐Yes ☒No

1. **Channel Water – assessment reach metric (skip for Size 1 streams and Tidal Marsh Streams)**
   - ☒A Water throughout assessment reach.
   - ☐B No flow, water in pools only.
   - ☐C No water in assessment reach.

2. **Evidence of Flow Restriction – assessment reach metric**
   - ☒A At least 10% of assessment reach in-stream habitat or riffle-pool sequence is severely affected by a flow restriction or fill to the point of obstructing flow or a channel choked with aquatic macrophytes or ponded water or impoundment on flood or ebb within the assessment reach (examples: undersized or perched culverts, causeways that constrict the channel, tidal gates, debris jams, beaver dams).
   - ☐B Not A

3. **Feature Pattern – assessment reach metric**
   - ☒A A majority of the assessment reach has altered pattern (examples: straightening, modification above or below culvert).
   - ☐B Not A

4. **Feature Longitudinal Profile – assessment reach metric**
   - ☒A Majority of assessment reach has a substantially altered stream profile (examples: channel down-cutting, existing damming, over widening, active aggradation, dredging, and excavation where appropriate channel profile has not reformed from any of these disturbances).
   - ☐B Not A

5. **Signs of Active Instability – assessment reach metric**
   Consider only current instability, not past events from which the stream has currently recovered. Examples of instability include active bank failure, active channel down-cutting (head-cut), active widening, and artificial hardening (such as concrete, gabion, rip-rap).
   - ☐A < 10% of channel unstable
   - ☐B 10 to 25% of channel unstable
   - ☒C > 25% of channel unstable

6. **Streamside Area Interaction – streamside area metric**
Consider for the Left Bank (LB) and the Right Bank (RB).

LB	RB	
☐A	☐A	Little or no evidence of conditions that adversely affect reference interaction
☐B	☐B	Moderate evidence of conditions (examples: berms, levees, down-cutting, aggradation, dredging) that adversely affect reference interaction (examples: limited streamside area access, disruption of flood flows through streamside area, leaky or intermittent bulkheads, causeways with floodplain constriction, minor ditching [including mosquito ditching])
☒C	☒C	Extensive evidence of conditions that adversely affect reference interaction (little to no floodplain/intertidal zone access [examples: causeways with floodplain and channel constriction, bulkheads, retaining walls, fill, stream incision, disruption of flood flows through streamside area] or too much floodplain/intertidal zone access [examples: impoundments, intensive mosquito ditching]) or floodplain/intertidal zone unnaturally absent or assessment reach is a man-made feature on an interstream divide

7. **Water Quality Stressors – assessment reach/intertidal zone metric**
Check all that apply.
- ☐A Discolored water in stream or intertidal zone (milky white, blue, unnatural water discoloration, oil sheen, stream foam)
- ☐B Excessive sedimentation (burying of stream features or intertidal zone)
- ☒C Noticeable evidence of pollutant discharges entering the assessment reach and causing a water quality problem
- ☐D Odor (not including natural sulfide odors)
- ☐E Current published or collected data indicating degraded water quality in the assessment reach. Cite source in “Notes/Sketch” section.
- ☐F Livestock with access to stream or intertidal zone
- ☐G Excessive algae in stream or intertidal zone
- ☐H Degraded marsh vegetation in the intertidal zone (removal, burning, regular mowing, destruction, etc)
- ☒I Other: ____________________ (explain in “Notes/Sketch” section)
- ☐J Little to no stressors

8. **Recent Weather – watershed metric (skip for Tidal Marsh Streams)**
For Size 1 or 2 streams, D1 drought or higher is considered a drought; for Size 3 or 4 streams, D2 drought or higher is considered a drought.
- ☐A Drought conditions and no rainfall or rainfall not exceeding 1 inch within the last 48 hours
- ☐B Drought conditions and rainfall exceeding 1 inch within the last 48 hours
- ☒C No drought conditions

9. **Large or Dangerous Stream – assessment reach metric**
☐Yes ☒No Is stream is too large or dangerous to assess? If Yes, skip to Metric 13 (Streamside Area Ground Surface Condition).

10. **Natural In-stream Habitat Types – assessment reach metric**

10a. ☒Yes ☐No Degraded in-stream habitat over majority of the assessment reach (examples of stressors include excessive sedimentation, mining, excavation, in-stream hardening [for example, rip-rap], recent dredging, and snagging) **(evaluate for Size 4 Coastal Plain streams only, then skip to Metric 12)**

10b. **Check all that occur** (occurs if > 5% coverage of assessment reach) **(skip for Size 4 Coastal Plain streams)**
- ☐A Multiple aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
- ☐B Multiple sticks and/or leaf packs and/or emergent vegetation
- ☐C Multiple snags and logs (including lap trees)
- ☐D 5% undercut banks and/or root mats and/or roots in banks extend to the normal wetted perimeter
- ☒E Little or no habitat

Check for Tidal Marsh Streams Only
- ☐F 5% oysters or other natural hard bottoms
- ☐G Submerged aquatic vegetation
- ☐H Low-tide refugia (pools)
- ☐I Sand bottom
- ☐J 5% vertical bank along the marsh
- ☐K Little or no habitat

**********************************REMAINING QUESTIONS ARE NOT APPLICABLE FOR TIDAL MARSH STREAMS****************************

11. **Bedform and Substrate – assessment reach metric (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**

11a. ☒Yes ☐No Is assessment reach in a natural sand-bed stream? **(skip for Coastal Plain streams)**

11b. Bedform evaluated. **Check the appropriate box(es).**
- ☐A Riffle-run section **(evaluate 11c)**
- ☐B Pool-glide section **(evaluate 11d)**
- ☒C Natural bedform absent **(skip to Metric 12, Aquatic Life)**

11c. In riffle sections, check all that occur below the normal wetted perimeter of the assessment reach – whether or not submerged. **Check at least one box in each row (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**. Not Present (NP) = absent, Rare (R) = present but ≤ 10%, Common (C) = > 10-40%, Abundant (A) = > 40-70%, Predominant (P) = > 70%. Cumulative percentages should not exceed 100% for each assessment reach.

NP	R	C	A	P	
☐	☐	☐	☐	☐	Bedrock/saprolite
☐	☐	☐	☐	☐	Boulder (256 – 4096 mm)
☐	☐	☐	☐	☐	Cobble (64 – 256 mm)
☐	☐	☐	☐	☐	Gravel (2 – 64 mm)
☐	☐	☐	☐	☐	Sand (.062 – 2 mm)
☐	☐	☐	☐	☐	Silt/clay (< 0.062 mm)
☐	☐	☐	☐	☐	Detritus
☐	☐	☐	☐	☐	Artificial (rip-rap, concrete, etc.)

11d. ☐Yes ☐No Are pools filled with sediment? (**skip for Size 4 Coastal Plain streams and Tidal Marsh Streams**)

12. Aquatic Life – assessment reach metric (skip for Tidal Marsh Streams)

12a. ☒Yes ☐No Was an in-stream aquatic life assessment performed as described in the User Manual?
If No, select one of the following reasons and skip to Metric 13. ☐No Water ☐Other: ______________________

12b. ☒Yes ☐No Are aquatic organisms present in the assessment reach (look in riffles, pools, then snags)? If Yes, check all that apply. If No, skip to Metric 13.

1	>1	Numbers over columns refer to "individuals" for Size 1 and 2 streams and "taxa" for Size 3 and 4 streams.
☐	☐	Adult frogs
☐	☐	Aquatic reptiles
☐	☐	Aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
☐	☐	Beetles
☐	☐	Caddisfly larvae (T)
☐	☐	Asian clam (*Corbicula*)
☐	☐	Crustacean (isopod/amphipod/crayfish/shrimp)
☐	☐	Damselfly and dragonfly larvae
☐	☐	Dipterans
☐	☐	Mayfly larvae (E)
☐	☐	Megaloptera (alderfly, fishfly, dobsonfly larvae)
☐	☒	Midges/mosquito larvae
☐	☐	Mosquito fish (*Gambusia*) or mud minnows (*Umbra pygmaea)*
☐	☐	Mussels/Clams (not *Corbicula*)
☐	☒	Other fish
☐	☐	Salamanders/tadpoles
☐	☐	Snails
☐	☐	Stonefly larvae (P)
☐	☐	Tipulid larvae
☐	☐	Worms/leeches

13. Streamside Area Ground Surface Condition – streamside area metric (skip for Tidal Marsh Streams and B valley types)
Consider for the Left Bank (LB) and the Right Bank (RB). Consider storage capacity with regard to both overbank flow and upland runoff.

LB	RB	
☐A	☐A	Little or no alteration to water storage capacity over a majority of the streamside area
☐B	☐B	Moderate alteration to water storage capacity over a majority of the streamside area
☒C	☒C	Severe alteration to water storage capacity over a majority of the streamside area (examples: ditches, fill, soil compaction, livestock disturbance, buildings, man-made levees, drainage pipes)

14. Streamside Area Water Storage – streamside area metric (skip for Size 1 streams, Tidal Marsh Streams, and B valley types)
Consider for the Left Bank (LB) and the Right Bank (RB) of the streamside area.

LB	RB	
☐A	☐A	Majority of streamside area with depressions able to pond water ≥ 6 inches deep
☐B	☐B	Majority of streamside area with depressions able to pond water 3 to 6 inches deep
☒C	☒C	Majority of streamside area with depressions able to pond water < 3 inches deep

15. Wetland Presence – streamside area metric (skip for Tidal Marsh Streams)
Consider for the Left Bank (LB) and the Right Bank (RB). Do not consider wetlands outside of the streamside area or within the normal wetted perimeter of assessment reach.

LB	RB	
☒Y	☒Y	Are wetlands present in the streamside area?
☐N	☐N	

16. Baseflow Contributors – assessment reach metric (skip for Size 4 streams and Tidal Marsh Streams)
Check all contributors within the assessment reach or within view of <u>and</u> draining to the assessment reach.

- ☒A Streams and/or springs (jurisdictional discharges)
- ☐B Ponds (include wet detention basins; do not include sediment basins or dry detention basins)
- ☒C Obstruction passing flow during low-flow periods within the assessment area (beaver dam, leaky dam, bottom-release dam, weir)
- ☐D Evidence of bank seepage or sweating (iron in water indicates seepage)
- ☐E Stream bed or bank soil reduced (dig through deposited sediment if present)
- ☐F None of the above

17. Baseflow Detractors – assessment area metric (skip for Tidal Marsh Streams)
Check all that apply.

- ☐A Evidence of substantial water withdrawals from the assessment reach (includes areas excavated for pump installation)
- ☐B Obstruction not passing flow during low-flow periods affecting the assessment reach (ex: watertight dam, sediment deposit)
- ☐C Urban stream (≥ 24% impervious surface for watershed)
- ☐D Evidence that the streamside area has been modified resulting in accelerated drainage into the assessment reach
- ☐E Assessment reach relocated to valley edge
- ☒F None of the above

18. Shading – assessment reach metric (skip for Tidal Marsh Streams)
Consider aspect. Consider "leaf-on" condition.

- ☐A Stream shading is appropriate for stream category (may include gaps associated with natural processes)
- ☐B Degraded (example: scattered trees)
- ☒C Stream shading is gone or largely absent

19. Buffer Width – streamside area metric (skip for Tidal Marsh Streams)
Consider "vegetated buffer" and "wooded buffer" separately for left bank (LB) and right bank (RB) starting at the top of bank out to the first break.

Vegetated LB	Vegetated RB	Wooded LB	Wooded RB	
☐A	☐A	☐A	☐A	≥ 100 feet wide or extends to the edge of the watershed
☐B	☐B	☐B	☐B	From 50 to < 100 feet wide
☐C	☐C	☐C	☐C	From 30 to < 50 feet wide
☐D	☐D	☐D	☐D	From 10 to < 30 feet wide
☒E	☒E	☒E	☒E	< 10 feet wide or no trees

20. Buffer Structure – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Vegetated" Buffer Width).

LB	RB	
☐A	☐A	Mature forest
☐B	☐B	Non-mature woody vegetation or modified vegetation structure
☐C	☐C	Herbaceous vegetation with or without a strip of trees < 10 feet wide
☐D	☐D	Maintained shrubs
☒E	☒E	Little or no vegetation

21. Buffer Stressors – streamside area metric (skip for Tidal Marsh Streams)
Check all appropriate boxes for left bank (LB) and right bank (RB). Indicate if listed stressor abuts stream (Abuts), does not abut but is within 30 feet of stream (< 30 feet), or is between 30 to 50 feet of stream (30-50 feet).
If none of the following stressors occurs on either bank, check here and skip to Metric 22: ☐

Abuts LB	Abuts RB	< 30 feet LB	< 30 feet RB	30-50 feet LB	30-50 feet RB	
☒A	☒A	☐A	☐A	☐A	☐A	Row crops
☐B	☐B	☐B	☐B	☐B	☐B	Maintained turf
☐C	☐C	☐C	☐C	☐C	☐C	Pasture (no livestock)/commercial horticulture
☐D	☐D	☐D	☐D	☐D	☐D	Pasture (active livestock use)

22. Stem Density – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Wooded" Buffer Width).

LB	RB	
☐A	☐A	Medium to high stem density
☐B	☐B	Low stem density
☒C	☒C	No wooded riparian buffer or predominantly herbaceous species or bare ground

23. Continuity of Vegetated Buffer – streamside area metric (skip for Tidal Marsh Streams)
Consider whether vegetated buffer is continuous along stream (parallel). Breaks are areas lacking vegetation > 10 feet wide.

LB	RB	
☐A	☐A	The total length of buffer breaks is < 25 percent.
☐B	☐B	The total length of buffer breaks is between 25 and 50 percent.
☒C	☒C	The total length of buffer breaks is > 50 percent.

24. Vegetative Composition – streamside area metric (skip for Tidal Marsh Streams)
Evaluate the dominant vegetation within 100 feet of each bank or to the edge of the watershed (whichever comes first) as it contributes to assessment reach habitat.

LB	RB	
☐A	☐A	Vegetation is close to undisturbed in species present and their proportions. Lower strata composed of native species, with non-native invasive species absent or sparse.
☐B	☐B	Vegetation indicates disturbance in terms of species diversity or proportions, but is still largely composed of native species. This may include communities of weedy native species that develop after clear-cutting or clearing or communities with non-native invasive species present, but not dominant, over a large portion of the expected strata or communities missing understory but retaining canopy trees.
☒C	☒C	Vegetation is severely disturbed in terms of species diversity or proportions. Mature canopy is absent or communities with non-native invasive species dominant over a large portion of expected strata or communities composed of planted stands of non-characteristic species or communities inappropriately composed of a single species or no vegetation.

25. Conductivity – assessment reach metric (skip for all Coastal Plain streams)
25a. ☐Yes ☒No Was conductivity measurement recorded?
If No, select one of the following reasons. ☐No Water ☐Other: ____________________

25b. Check the box corresponding to the conductivity measurement (units of microsiemens per centimeter).
☐A < 46 ☐B 46 to < 67 ☐C 67 to < 79 ☐D 79 to < 230 ☐E ≥ 230

Notes/Sketch:

Draft NC SAM Stream Rating Sheet
Accompanies User Manual Version 2.1

Stream Site Name	Hornpipe Branch Tributaries MS2	Date of Assessment	12-4-2019
Stream Category	Ia2	Assessor Name/Organization	Kyle Obermiller - WLS

Notes of Field Assessment Form (Y/N)	NO
Presence of regulatory considerations (Y/N)	NO
Additional stream information/supplementary measurements included (Y/N)	NO
NC SAM feature type (perennial, intermittent, Tidal Marsh Stream)	Perennial

Function Class Rating Summary	**USACE/ All Streams**	**NCDWR Intermittent**
(1) Hydrology	**LOW**	
(2) Baseflow	**HIGH**	
(2) Flood Flow	**LOW**	
(3) Streamside Area Attenuation	**LOW**	
(4) Floodplain Access	**LOW**	
(4) Wooded Riparian Buffer	**LOW**	
(4) Microtopography	**LOW**	
(3) Stream Stability	**LOW**	
(4) Channel Stability	**LOW**	
(4) Sediment Transport	**LOW**	
(4) Stream Geomorphology	**LOW**	
(2) Stream/Intertidal Zone Interaction	NA	
(2) Longitudinal Tidal Flow	NA	
(2) Tidal Marsh Stream Stability	NA	
(3) Tidal Marsh Channel Stability	NA	
(3) Tidal Marsh Stream Geomorphology	NA	
(1) Water Quality	**LOW**	
(2) Baseflow	**HIGH**	
(2) Streamside Area Vegetation	**LOW**	
(3) Upland Pollutant Filtration	**LOW**	
(3) Thermoregulation	**LOW**	
(2) Indicators of Stressors	**YES**	
(2) Aquatic Life Tolerance	**LOW**	
(2) Intertidal Zone Filtration	NA	
(1) Habitat	**LOW**	
(2) In-stream Habitat	**LOW**	
(3) Baseflow	**HIGH**	
(3) Substrate	**LOW**	
(3) Stream Stability	**LOW**	
(3) In-stream Habitat	**LOW**	
(2) Stream-side Habitat	**LOW**	
(3) Stream-side Habitat	**LOW**	
(3) Thermoregulation	**LOW**	
(2) Tidal Marsh In-stream Habitat	NA	
(3) Flow Restriction	NA	
(3) Tidal Marsh Stream Stability	NA	
(4) Tidal Marsh Channel Stability	NA	
(4) Tidal Marsh Stream Geomorphology	NA	
(3) Tidal Marsh In-stream Habitat	NA	
(2) Intertidal Zone	NA	
Overall	**LOW**	

NC SAM FIELD ASSESSMENT FORM
Accompanies User Manual Version 2.1

USACE AID #: NCDWR #:

INSTRUCTIONS: Attach a sketch of the assessment area and photographs. Attach a copy of the USGS 7.5-minute topographic quadrangle, and circle the location of the stream reach under evaluation. If multiple stream reaches will be evaluated on the same property, identify and number all reaches on the attached map, and include a separate form for each reach. See the NC SAM User Manual for detailed descriptions and explanations of requested information. Record in the "Notes/Sketch" section if supplementary measurements were performed. See the NC SAM User Manual for examples of additional measurements that may be relevant.

NOTE EVIDENCE OF STRESSORS AFFECTING THE ASSESSMENT AREA (do not need to be within the assessment area).

PROJECT/SITE INFORMATION:

1. Project name (if any): Hornpipe Branch Tributaries MS3
2. Date of evaluation: 12-4-2019
3. Applicant/owner name: Water & Land Solutions
4. Assessor name/organization: Kyle Obermiller - WLS
5. County: Lenoir
6. Nearest named water body on USGS 7.5-minute quad: Hornpipe Branch
7. River basin: Neuse
8. Site coordinates (decimal degrees, at lower end of assessment reach): 35.13306, -77.65599

STREAM INFORMATION: (depth and width can be approximations)

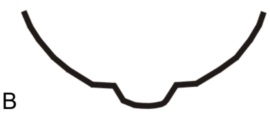
9. Site number (show on attached map): MS3
10. Length of assessment reach evaluated (feet): 1093
11. Channel depth from bed (in riffle, if present) to top of bank (feet): 4.5 ☐Unable to assess channel depth.
12. Channel width at top of bank (feet): 6
13. Is assessment reach a swamp steam? ☐Yes ☒No
14. Feature type: ☒Perennial flow ☐Intermittent flow ☐Tidal Marsh Stream

STREAM CATEGORY INFORMATION:

15. NC SAM Zone: ☐ Mountains (M) ☐ Piedmont (P) ☒ Inner Coastal Plain (I) ☐ Outer Coastal Plain (O)

16. Estimated geomorphic valley shape (**skip for Tidal Marsh Stream**):

☒A 
(more sinuous stream, flatter valley slope)

☐B 
(less sinuous stream, steeper valley slope)

17. Watershed size: (**skip for Tidal Marsh Stream**) ☐Size 1 (< 0.1 mi^2) ☐Size 2 (0.1 to < 0.5 mi^2) ☒Size 3 (0.5 to < 5 mi^2) ☐Size 4 (≥ 5 mi^2)

ADDITIONAL INFORMATION:

18. Were regulatory considerations evaluated? ☒Yes ☐No If Yes, check all that apply to the assessment area.
- ☐Section 10 water
- ☐Classified Trout Waters
- ☐Water Supply Watershed (☐I ☐II ☐III ☐IV ☐V)
- ☐Essential Fish Habitat
- ☐Primary Nursery Area
- ☐ High Quality Waters/Outstanding Resource Waters
- ☐Publicly owned property
- ☐NCDWR Riparian buffer rule in effect
- ☐Nutrient Sensitive Waters
- ☐Anadromous fish
- ☐303(d) List
- ☐CAMA Area of Environmental Concern (AEC)
- ☐Documented presence of a federal and/or state listed protected species within the assessment area.
  List species:
- ☐Designated Critical Habitat (list species)

19. Are additional stream information/supplementary measurements included in "Notes/Sketch" section or attached? ☐Yes ☒No

1. Channel Water – assessment reach metric (skip for Size 1 streams and Tidal Marsh Streams)

☒A Water throughout assessment reach.
☐B No flow, water in pools only.
☐C No water in assessment reach.

2. Evidence of Flow Restriction – assessment reach metric

☐A At least 10% of assessment reach in-stream habitat or riffle-pool sequence is severely affected by a flow restriction or fill to the point of obstructing flow or a channel choked with aquatic macrophytes or ponded water or impoundment on flood or ebb within the assessment reach (examples: undersized or perched culverts, causeways that constrict the channel, tidal gates, debris jams, beaver dams).
☒B Not A

3. Feature Pattern – assessment reach metric

☐A A majority of the assessment reach has altered pattern (examples: straightening, modification above or below culvert).
☒B Not A

4. Feature Longitudinal Profile – assessment reach metric

☒A Majority of assessment reach has a substantially altered stream profile (examples: channel down-cutting, existing damming, over widening, active aggradation, dredging, and excavation where appropriate channel profile has not reformed from any of these disturbances).
☐B Not A

5. Signs of Active Instability – assessment reach metric

Consider only current instability, not past events from which the stream has currently recovered. Examples of instability include active bank failure, active channel down-cutting (head-cut), active widening, and artificial hardening (such as concrete, gabion, rip-rap).

☐A < 10% of channel unstable
☐B 10 to 25% of channel unstable
☒C > 25% of channel unstable

6. **Streamside Area Interaction – streamside area metric**
Consider for the Left Bank (LB) and the Right Bank (RB).

LB	RB	
☐A	☐A	Little or no evidence of conditions that adversely affect reference interaction
☐B	☐B	Moderate evidence of conditions (examples: berms, levees, down-cutting, aggradation, dredging) that adversely affect reference interaction (examples: limited streamside area access, disruption of flood flows through streamside area, leaky or intermittent bulkheads, causeways with floodplain constriction, minor ditching [including mosquito ditching])
☒C	☒C	Extensive evidence of conditions that adversely affect reference interaction (little to no floodplain/intertidal zone access [examples: causeways with floodplain and channel constriction, bulkheads, retaining walls, fill, stream incision, disruption of flood flows through streamside area] or too much floodplain/intertidal zone access [examples: impoundments, intensive mosquito ditching]) or floodplain/intertidal zone unnaturally absent or assessment reach is a man-made feature on an interstream divide

7. **Water Quality Stressors – assessment reach/intertidal zone metric**
Check all that apply.
- ☐A Discolored water in stream or intertidal zone (milky white, blue, unnatural water discoloration, oil sheen, stream foam)
- ☒B Excessive sedimentation (burying of stream features or intertidal zone)
- ☐C Noticeable evidence of pollutant discharges entering the assessment reach and causing a water quality problem
- ☐D Odor (not including natural sulfide odors)
- ☐E Current published or collected data indicating degraded water quality in the assessment reach. Cite source in “Notes/Sketch” section.
- ☐F Livestock with access to stream or intertidal zone
- ☐G Excessive algae in stream or intertidal zone
- ☐H Degraded marsh vegetation in the intertidal zone (removal, burning, regular mowing, destruction, etc)
- ☐I Other: ____________________ (explain in “Notes/Sketch” section)
- ☐J Little to no stressors

8. **Recent Weather – watershed metric (skip for Tidal Marsh Streams)**
For Size 1 or 2 streams, D1 drought or higher is considered a drought; for Size 3 or 4 streams, D2 drought or higher is considered a drought.
- ☐A Drought conditions and no rainfall or rainfall not exceeding 1 inch within the last 48 hours
- ☐B Drought conditions and rainfall exceeding 1 inch within the last 48 hours
- ☒C No drought conditions

9. **Large or Dangerous Stream – assessment reach metric**
☐Yes ☒No Is stream is too large or dangerous to assess? If Yes, skip to Metric 13 (Streamside Area Ground Surface Condition).

10. **Natural In-stream Habitat Types – assessment reach metric**
10a. ☒Yes ☐No Degraded in-stream habitat over majority of the assessment reach (examples of stressors include excessive sedimentation, mining, excavation, in-stream hardening [for example, rip-rap], recent dredging, and snagging) **(evaluate for Size 4 Coastal Plain streams only, then skip to Metric 12)**

10b. **Check all that occur** (occurs if > 5% coverage of assessment reach) **(skip for Size 4 Coastal Plain streams)**
- ☐A Multiple aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
- ☐B Multiple sticks and/or leaf packs and/or emergent vegetation
- ☒C Multiple snags and logs (including lap trees)
- ☐D 5% undercut banks and/or root mats and/or roots in banks extend to the normal wetted perimeter
- ☐E Little or no habitat

Check for Tidal Marsh Streams Only
- ☐F 5% oysters or other natural hard bottoms
- ☐G Submerged aquatic vegetation
- ☐H Low-tide refugia (pools)
- ☐I Sand bottom
- ☐J 5% vertical bank along the marsh
- ☐K Little or no habitat

**********************************REMAINING QUESTIONS ARE NOT APPLICABLE FOR TIDAL MARSH STREAMS****************************

11. **Bedform and Substrate – assessment reach metric (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**

11a. ☒Yes ☐No Is assessment reach in a natural sand-bed stream? **(skip for Coastal Plain streams)**

11b. Bedform evaluated. **Check the appropriate box(es).**
- ☒A Riffle-run section **(evaluate 11c)**
- ☐B Pool-glide section **(evaluate 11d)**
- ☐C Natural bedform absent **(skip to Metric 12, Aquatic Life)**

11c. In riffle sections, check all that occur below the normal wetted perimeter of the assessment reach – whether or not submerged. **Check at least one box in each row (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**. Not Present (NP) = absent, Rare (R) = present but $\leq$ 10%, Common (C) = > 10-40%, Abundant (A) = > 40-70%, Predominant (P) = > 70%. Cumulative percentages should not exceed 100% for each assessment reach.

NP	R	C	A	P	
☒	☐	☐	☐	☐	Bedrock/saprolite
☒	☐	☐	☐	☐	Boulder (256 – 4096 mm)
☐	☒	☐	☐	☐	Cobble (64 – 256 mm)
☐	☒	☐	☐	☐	Gravel (2 – 64 mm)
☐	☐	☐	☒	☐	Sand (.062 – 2 mm)
☐	☐	☒	☐	☐	Silt/clay (< 0.062 mm)
☒	☐	☐	☐	☐	Detritus
☒	☐	☐	☐	☐	Artificial (rip-rap, concrete, etc.)

11d. ☐Yes ☐No Are pools filled with sediment? (**skip for Size 4 Coastal Plain streams and Tidal Marsh Streams**)

12. Aquatic Life – assessment reach metric (skip for Tidal Marsh Streams)

12a. ☒Yes ☐No Was an in-stream aquatic life assessment performed as described in the User Manual?
If No, select one of the following reasons and skip to Metric 13. ☐No Water ☐Other: ____________________

12b. ☒Yes ☐No Are aquatic organisms present in the assessment reach (look in riffles, pools, then snags)? If Yes, check all that apply. If No, skip to Metric 13.

1	>1	Numbers over columns refer to "individuals" for Size 1 and 2 streams and "taxa" for Size 3 and 4 streams.
☐	☐	Adult frogs
☐	☐	Aquatic reptiles
☐	☐	Aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
☐	☐	Beetles
☐	☐	Caddisfly larvae (T)
☐	☐	Asian clam (*Corbicula*)
☒	☐	Crustacean (isopod/amphipod/crayfish/shrimp)
☐	☐	Damselfly and dragonfly larvae
☒	☐	Dipterans
☐	☐	Mayfly larvae (E)
☐	☐	Megaloptera (alderfly, fishfly, dobsonfly larvae)
☐	☐	Midges/mosquito larvae
☐	☐	Mosquito fish (*Gambusia*) or mud minnows (*Umbra pygmaea)*
☐	☐	Mussels/Clams (not *Corbicula*)
☐	☒	Other fish
☐	☐	Salamanders/tadpoles
☐	☐	Snails
☐	☐	Stonefly larvae (P)
☐	☐	Tipulid larvae
☐	☐	Worms/leeches

13. Streamside Area Ground Surface Condition – streamside area metric (skip for Tidal Marsh Streams and B valley types)
Consider for the Left Bank (LB) and the Right Bank (RB). Consider storage capacity with regard to both overbank flow and upland runoff.

LB	RB	
☐A	☐A	Little or no alteration to water storage capacity over a majority of the streamside area
☐B	☐B	Moderate alteration to water storage capacity over a majority of the streamside area
☒C	☒C	Severe alteration to water storage capacity over a majority of the streamside area (examples: ditches, fill, soil compaction, livestock disturbance, buildings, man-made levees, drainage pipes)

14. Streamside Area Water Storage – streamside area metric (skip for Size 1 streams, Tidal Marsh Streams, and B valley types)
Consider for the Left Bank (LB) and the Right Bank (RB) of the streamside area.

LB	RB	
☐A	☐A	Majority of streamside area with depressions able to pond water ≥ 6 inches deep
☒B	☒B	Majority of streamside area with depressions able to pond water 3 to 6 inches deep
☐C	☐C	Majority of streamside area with depressions able to pond water < 3 inches deep

15. Wetland Presence – streamside area metric (skip for Tidal Marsh Streams)
Consider for the Left Bank (LB) and the Right Bank (RB). Do not consider wetlands outside of the streamside area or within the normal wetted perimeter of assessment reach.

LB	RB	
☐Y	☐Y	Are wetlands present in the streamside area?
☒N	☒N	

16. Baseflow Contributors – assessment reach metric (skip for Size 4 streams and Tidal Marsh Streams)
Check all contributors within the assessment reach or within view of <u>and</u> draining to the assessment reach.

- ☒A Streams and/or springs (jurisdictional discharges)
- ☐B Ponds (include wet detention basins; do not include sediment basins or dry detention basins)
- ☒C Obstruction passing flow during low-flow periods within the assessment area (beaver dam, leaky dam, bottom-release dam, weir)
- ☐D Evidence of bank seepage or sweating (iron in water indicates seepage)
- ☐E Stream bed or bank soil reduced (dig through deposited sediment if present)
- ☐F None of the above

17. Baseflow Detractors – assessment area metric (skip for Tidal Marsh Streams)
Check all that apply.

- ☐A Evidence of substantial water withdrawals from the assessment reach (includes areas excavated for pump installation)
- ☐B Obstruction not passing flow during low-flow periods affecting the assessment reach (ex: watertight dam, sediment deposit)
- ☐C Urban stream (≥ 24% impervious surface for watershed)
- ☐D Evidence that the streamside area has been modified resulting in accelerated drainage into the assessment reach
- ☐E Assessment reach relocated to valley edge
- ☒F None of the above

18. Shading – assessment reach metric (skip for Tidal Marsh Streams)
Consider aspect. Consider "leaf-on" condition.

- ☒A Stream shading is appropriate for stream category (may include gaps associated with natural processes)
- ☐B Degraded (example: scattered trees)
- ☐C Stream shading is gone or largely absent

19. Buffer Width – streamside area metric (skip for Tidal Marsh Streams)
Consider "vegetated buffer" and "wooded buffer" separately for left bank (LB) and right bank (RB) starting at the top of bank out to the first break.

Vegetated		Wooded		
LB	RB	LB	RB	
☐A	☒A	☐A	☒A	≥ 100 feet wide <u>or</u> extends to the edge of the watershed
☒B	☐B	☒B	☐B	From 50 to < 100 feet wide
☐C	☐C	☐C	☐C	From 30 to < 50 feet wide
☐D	☐D	☐D	☐D	From 10 to < 30 feet wide
☐E	☐E	☐E	☐E	< 10 feet wide <u>or</u> no trees

20. Buffer Structure – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Vegetated" Buffer Width).

LB	RB	
☒A	☒A	Mature forest
☐B	☐B	Non-mature woody vegetation <u>or</u> modified vegetation structure
☐C	☐C	Herbaceous vegetation with or without a strip of trees < 10 feet wide
☐D	☐D	Maintained shrubs
☐E	☐E	Little or no vegetation

21. Buffer Stressors – streamside area metric (skip for Tidal Marsh Streams)
Check all appropriate boxes for left bank (LB) and right bank (RB). Indicate if listed stressor abuts stream (Abuts), does not abut but is within 30 feet of stream (< 30 feet), or is between 30 to 50 feet of stream (30-50 feet).
If none of the following stressors occurs on either bank, check here and skip to Metric 22: ☐

Abuts		< 30 feet		30-50 feet		
LB	RB	LB	RB	LB	RB	
☐A	☐A	☐A	☐A	☒A	☐A	Row crops
☐B	☐B	☐B	☐B	☐B	☐B	Maintained turf
☐C	☐C	☐C	☐C	☐C	☐C	Pasture (no livestock)/commercial horticulture
☐D	☐D	☐D	☐D	☐D	☐D	Pasture (active livestock use)

22. Stem Density – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Wooded" Buffer Width).

LB	RB	
☒A	☒A	Medium to high stem density
☐B	☐B	Low stem density
☐C	☐C	No wooded riparian buffer <u>or</u> predominantly herbaceous species <u>or</u> bare ground

23. Continuity of Vegetated Buffer – streamside area metric (skip for Tidal Marsh Streams)
Consider whether vegetated buffer is continuous along stream (parallel). Breaks are areas lacking vegetation > 10 feet wide.

LB	RB	
☒A	☒A	The total length of buffer breaks is < 25 percent.
☐B	☐B	The total length of buffer breaks is between 25 and 50 percent.
☐C	☐C	The total length of buffer breaks is > 50 percent.

24. Vegetative Composition – streamside area metric (skip for Tidal Marsh Streams)
Evaluate the dominant vegetation within 100 feet of each bank or to the edge of the watershed (whichever comes first) as it contributes to assessment reach habitat.

LB	RB	
☐A	☐A	Vegetation is close to undisturbed in species present and their proportions. Lower strata composed of native species, with non-native invasive species absent or sparse.
☐B	☐B	Vegetation indicates disturbance in terms of species diversity or proportions, but is still largely composed of native species. This may include communities of weedy native species that develop after clear-cutting or clearing <u>or</u> communities with non-native invasive species present, but not dominant, over a large portion of the expected strata <u>or</u> communities missing understory but retaining canopy trees.
☒C	☒C	Vegetation is severely disturbed in terms of species diversity or proportions. Mature canopy is absent <u>or</u> communities with non-native invasive species dominant over a large portion of expected strata <u>or</u> communities composed of planted stands of non-characteristic species <u>or</u> communities inappropriately composed of a single species <u>or</u> no vegetation.

25. Conductivity – assessment reach metric (skip for all Coastal Plain streams)
25a. ☐Yes ☒No Was conductivity measurement recorded?
If No, select one of the following reasons. ☐No Water ☐Other: ______________________________

25b. Check the box corresponding to the conductivity measurement (units of microsiemens per centimeter).
☐A < 46 ☐B 46 to < 67 ☐C 67 to < 79 ☐D 79 to < 230 ☐E ≥ 230

Notes/Sketch:

Draft NC SAM Stream Rating Sheet
Accompanies User Manual Version 2.1

Stream Site Name	Hornpipe Branch Tributaries MS3	Date of Assessment	12-4-2019
Stream Category	Ia3	Assessor Name/Organization	Kyle Obermiller - WLS

Notes of Field Assessment Form (Y/N)	NO
Presence of regulatory considerations (Y/N)	NO
Additional stream information/supplementary measurements included (Y/N)	NO
NC SAM feature type (perennial, intermittent, Tidal Marsh Stream)	Perennial

Function Class Rating Summary	**USACE/ All Streams**	**NCDWR Intermittent**
(1) Hydrology	**LOW**	
(2) Baseflow	**HIGH**	
(2) Flood Flow	**LOW**	
(3) Streamside Area Attenuation	**LOW**	
(4) Floodplain Access	**LOW**	
(4) Wooded Riparian Buffer	**HIGH**	
(4) Microtopography	**LOW**	
(3) Stream Stability	**LOW**	
(4) Channel Stability	**LOW**	
(4) Sediment Transport	**LOW**	
(4) Stream Geomorphology	**MEDIUM**	
(2) Stream/Intertidal Zone Interaction	NA	
(2) Longitudinal Tidal Flow	NA	
(2) Tidal Marsh Stream Stability	NA	
(3) Tidal Marsh Channel Stability	NA	
(3) Tidal Marsh Stream Geomorphology	NA	
(1) Water Quality	**LOW**	
(2) Baseflow	**HIGH**	
(2) Streamside Area Vegetation	**MEDIUM**	
(3) Upland Pollutant Filtration	**MEDIUM**	
(3) Thermoregulation	**HIGH**	
(2) Indicators of Stressors	**YES**	
(2) Aquatic Life Tolerance	**MEDIUM**	
(2) Intertidal Zone Filtration	NA	
(1) Habitat	**LOW**	
(2) In-stream Habitat	**LOW**	
(3) Baseflow	**HIGH**	
(3) Substrate	**HIGH**	
(3) Stream Stability	**LOW**	
(3) In-stream Habitat	**LOW**	
(2) Stream-side Habitat	**HIGH**	
(3) Stream-side Habitat	**MEDIUM**	
(3) Thermoregulation	**HIGH**	
(2) Tidal Marsh In-stream Habitat	NA	
(3) Flow Restriction	NA	
(3) Tidal Marsh Stream Stability	NA	
(4) Tidal Marsh Channel Stability	NA	
(4) Tidal Marsh Stream Geomorphology	NA	
(3) Tidal Marsh In-stream Habitat	NA	
(2) Intertidal Zone	NA	
Overall	**LOW**	

NC SAM FIELD ASSESSMENT FORM
Accompanies User Manual Version 2.1

USACE AID #: NCDWR #:

INSTRUCTIONS: Attach a sketch of the assessment area and photographs. Attach a copy of the USGS 7.5-minute topographic quadrangle, and circle the location of the stream reach under evaluation. If multiple stream reaches will be evaluated on the same property, identify and number all reaches on the attached map, and include a separate form for each reach. See the NC SAM User Manual for detailed descriptions and explanations of requested information. Record in the "Notes/Sketch" section if supplementary measurements were performed. See the NC SAM User Manual for examples of additional measurements that may be relevant.

NOTE EVIDENCE OF STRESSORS AFFECTING THE ASSESSMENT AREA (do not need to be within the assessment area).

PROJECT/SITE INFORMATION:

1. Project name (if any): Hornpipe Branch Tributaries UT1
2. Date of evaluation: 12-4-2019
3. Applicant/owner name: Water & Land Solutions
4. Assessor name/organization: Kyle Obermiller - WLS
5. County: Lenoir
6. Nearest named water body on USGS 7.5-minute quad: Hornpipe Branch
7. River basin: Neuse
8. Site coordinates (decimal degrees, at lower end of assessment reach): 35.13488, -77.65495

STREAM INFORMATION: (depth and width can be approximations)

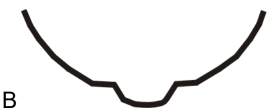
9. Site number (show on attached map): UT1
10. Length of assessment reach evaluated (feet): 848
11. Channel depth from bed (in riffle, if present) to top of bank (feet): 4 ☐Unable to assess channel depth.
12. Channel width at top of bank (feet): 4
13. Is assessment reach a swamp steam? ☐Yes ☒No
14. Feature type: ☒Perennial flow ☐Intermittent flow ☐Tidal Marsh Stream

STREAM CATEGORY INFORMATION:

15. NC SAM Zone: ☐ Mountains (M) ☐ Piedmont (P) ☒ Inner Coastal Plain (I) ☐ Outer Coastal Plain (O)

16. Estimated geomorphic valley shape (**skip for Tidal Marsh Stream**):

☒A 
(more sinuous stream, flatter valley slope)

☐B 
(less sinuous stream, steeper valley slope)

17. Watershed size: (**skip for Tidal Marsh Stream**) ☒Size 1 (< 0.1 mi^2) ☐Size 2 (0.1 to < 0.5 mi^2) ☐Size 3 (0.5 to < 5 mi^2) ☐Size 4 (≥ 5 mi^2)

ADDITIONAL INFORMATION:

18. Were regulatory considerations evaluated? ☒Yes ☐No If Yes, check all that apply to the assessment area.
    - ☐Section 10 water
    - ☐Classified Trout Waters
    - ☐Water Supply Watershed (☐I ☐II ☐III ☐IV ☐V)
    - ☐Essential Fish Habitat
    - ☐Primary Nursery Area
    - ☐ High Quality Waters/Outstanding Resource Waters
    - ☐Publicly owned property
    - ☐NCDWR Riparian buffer rule in effect
    - ☐Nutrient Sensitive Waters
    - ☐Anadromous fish
    - ☐303(d) List
    - ☐CAMA Area of Environmental Concern (AEC)
    - ☐Documented presence of a federal and/or state listed protected species within the assessment area.
      List species:
    - ☐Designated Critical Habitat (list species)
19. Are additional stream information/supplementary measurements included in "Notes/Sketch" section or attached? ☐Yes ☒No

1. Channel Water – assessment reach metric (skip for Size 1 streams and Tidal Marsh Streams)

☒A Water throughout assessment reach.
☐B No flow, water in pools only.
☐C No water in assessment reach.

2. Evidence of Flow Restriction – assessment reach metric

☐A At least 10% of assessment reach in-stream habitat or riffle-pool sequence is severely affected by a flow restriction or fill to the point of obstructing flow or a channel choked with aquatic macrophytes or ponded water or impoundment on flood or ebb within the assessment reach (examples: undersized or perched culverts, causeways that constrict the channel, tidal gates, debris jams, beaver dams).
☒B Not A

3. Feature Pattern – assessment reach metric

☒A A majority of the assessment reach has altered pattern (examples: straightening, modification above or below culvert).
☐B Not A

4. Feature Longitudinal Profile – assessment reach metric

☒A Majority of assessment reach has a substantially altered stream profile (examples: channel down-cutting, existing damming, over widening, active aggradation, dredging, and excavation where appropriate channel profile has not reformed from any of these disturbances).
☐B Not A

5. Signs of Active Instability – assessment reach metric

Consider only current instability, not past events from which the stream has currently recovered. Examples of instability include active bank failure, active channel down-cutting (head-cut), active widening, and artificial hardening (such as concrete, gabion, rip-rap).

☐A < 10% of channel unstable
☐B 10 to 25% of channel unstable
☒C > 25% of channel unstable

6. Streamside Area Interaction – streamside area metric
Consider for the Left Bank (LB) and the Right Bank (RB).

LB	RB	
☐A	☐A	Little or no evidence of conditions that adversely affect reference interaction
☐B	☐B	Moderate evidence of conditions (examples: berms, levees, down-cutting, aggradation, dredging) that adversely affect reference interaction (examples: limited streamside area access, disruption of flood flows through streamside area, leaky or intermittent bulkheads, causeways with floodplain constriction, minor ditching [including mosquito ditching])
☒C	☒C	Extensive evidence of conditions that adversely affect reference interaction (little to no floodplain/intertidal zone access [examples: causeways with floodplain and channel constriction, bulkheads, retaining walls, fill, stream incision, disruption of flood flows through streamside area] <u>or</u> too much floodplain/intertidal zone access [examples: impoundments, intensive mosquito ditching]) <u>or</u> floodplain/intertidal zone unnaturally absent <u>or</u> assessment reach is a man-made feature on an interstream divide

7. Water Quality Stressors – assessment reach/intertidal zone metric
Check all that apply.

- ☐A Discolored water in stream or intertidal zone (milky white, blue, unnatural water discoloration, oil sheen, stream foam)
- ☐B <u>Excessive</u> sedimentation (burying of stream features or intertidal zone)
- ☒C Noticeable evidence of pollutant discharges entering the assessment reach <u>and</u> causing a water quality problem
- ☐D Odor (not including natural sulfide odors)
- ☐E Current published or collected data indicating degraded water quality in the assessment reach. Cite source in “Notes/Sketch” section.
- ☐F Livestock with access to stream or intertidal zone
- ☐G Excessive algae in stream or intertidal zone
- ☐H Degraded marsh vegetation in the intertidal zone (removal, burning, regular mowing, destruction, etc)
- ☒I Other: ____________________ (explain in “Notes/Sketch” section)
- ☐J Little to no stressors

8. Recent Weather – watershed metric (skip for Tidal Marsh Streams)
For Size 1 or 2 streams, D1 drought or higher is considered a drought; for Size 3 or 4 streams, D2 drought or higher is considered a drought.

- ☐A Drought conditions <u>and</u> no rainfall or rainfall not exceeding 1 inch within the last 48 hours
- ☐B Drought conditions <u>and</u> rainfall exceeding 1 inch within the last 48 hours
- ☒C No drought conditions

9. Large or Dangerous Stream – assessment reach metric
☐Yes ☒No Is stream is too large or dangerous to assess? If Yes, skip to Metric 13 (Streamside Area Ground Surface Condition).

10. Natural In-stream Habitat Types – assessment reach metric
10a. ☒Yes ☐No Degraded in-stream habitat over majority of the assessment reach (examples of stressors include excessive sedimentation, mining, excavation, in-stream hardening [for example, rip-rap], recent dredging, and snagging) **(evaluate for Size 4 Coastal Plain streams only, then skip to Metric 12)**

10b. **Check all that occur** (occurs if > 5% coverage of assessment reach) **(skip for Size 4 Coastal Plain streams)**

- ☐A Multiple aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
- ☐B Multiple sticks and/or leaf packs and/or emergent vegetation
- ☐C Multiple snags and logs (including lap trees)
- ☐D 5% undercut banks and/or root mats and/or roots in banks extend to the normal wetted perimeter
- ☒E Little or no habitat

Check for Tidal Marsh Streams Only

- ☐F 5% oysters or other natural hard bottoms
- ☐G Submerged aquatic vegetation
- ☐H Low-tide refugia (pools)
- ☐I Sand bottom
- ☐J 5% vertical bank along the marsh
- ☐K Little or no habitat

**********************************REMAINING QUESTIONS ARE NOT APPLICABLE FOR TIDAL MARSH STREAMS*****************************

11. Bedform and Substrate – assessment reach metric (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)

11a. ☒Yes ☐No Is assessment reach in a natural sand-bed stream? **(skip for Coastal Plain streams)**

11b. Bedform evaluated. **Check the appropriate box(es).**

- ☐A Riffle-run section **(evaluate 11c)**
- ☐B Pool-glide section **(evaluate 11d)**
- ☒C Natural bedform absent **(skip to Metric 12, Aquatic Life)**

11c. In riffle sections, check all that occur below the normal wetted perimeter of the assessment reach – whether or not submerged. **Check at least one box in each row (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**. Not Present (NP) = absent, Rare (R) = present but ≤ 10%, Common (C) = > 10-40%, Abundant (A) = > 40-70%, Predominant (P) = > 70%. Cumulative percentages should not exceed 100% for each assessment reach.

NP	R	C	A	P	
☐	☐	☐	☐	☐	Bedrock/saprolite
☐	☐	☐	☐	☐	Boulder (256 – 4096 mm)
☐	☐	☐	☐	☐	Cobble (64 – 256 mm)
☐	☐	☐	☐	☐	Gravel (2 – 64 mm)
☐	☐	☐	☐	☐	Sand (.062 – 2 mm)
☐	☐	☐	☐	☐	Silt/clay (< 0.062 mm)
☐	☐	☐	☐	☐	Detritus
☐	☐	☐	☐	☐	Artificial (rip-rap, concrete, etc.)

11d. ☐Yes ☐No Are pools filled with sediment? (**skip for Size 4 Coastal Plain streams and Tidal Marsh Streams**)

12. **Aquatic Life – assessment reach metric (skip for Tidal Marsh Streams)**

12a. ☒Yes ☐No Was an in-stream aquatic life assessment performed as described in the User Manual?
If No, select one of the following reasons and skip to Metric 13. ☐No Water ☐Other: ______

12b. ☒Yes ☐No Are aquatic organisms present in the assessment reach (look in riffles, pools, then snags)? If Yes, check all that apply. If No, skip to Metric 13.

1	>1	Numbers over columns refer to "individuals" for Size 1 and 2 streams and "taxa" for Size 3 and 4 streams.
☐	☐	Adult frogs
☐	☐	Aquatic reptiles
☐	☐	Aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
☐	☐	Beetles
☐	☐	Caddisfly larvae (T)
☐	☐	Asian clam (*Corbicula*)
☒	☐	Crustacean (isopod/amphipod/crayfish/shrimp)
☐	☐	Damselfly and dragonfly larvae
☐	☐	Dipterans
☐	☐	Mayfly larvae (E)
☐	☐	Megaloptera (alderfly, fishfly, dobsonfly larvae)
☐	☒	Midges/mosquito larvae
☐	☐	Mosquito fish (*Gambusia*) or mud minnows (*Umbra pygmaea)*
☐	☐	Mussels/Clams (not *Corbicula*)
☐	☒	Other fish
☐	☐	Salamanders/tadpoles
☐	☐	Snails
☐	☐	Stonefly larvae (P)
☐	☐	Tipulid larvae
☐	☐	Worms/leeches

13. **Streamside Area Ground Surface Condition – streamside area metric (skip for Tidal Marsh Streams and B valley types)**
Consider for the Left Bank (LB) and the Right Bank (RB). Consider storage capacity with regard to both overbank flow and upland runoff.

LB	RB	
☐A	☐A	Little or no alteration to water storage capacity over a majority of the streamside area
☐B	☐B	Moderate alteration to water storage capacity over a majority of the streamside area
☒C	☒C	Severe alteration to water storage capacity over a majority of the streamside area (examples: ditches, fill, soil compaction, livestock disturbance, buildings, man-made levees, drainage pipes)

14. **Streamside Area Water Storage – streamside area metric (skip for Size 1 streams, Tidal Marsh Streams, and B valley types)**
Consider for the Left Bank (LB) and the Right Bank (RB) of the streamside area.

LB	RB	
☐A	☐A	Majority of streamside area with depressions able to pond water ≥ 6 inches deep
☐B	☐B	Majority of streamside area with depressions able to pond water 3 to 6 inches deep
☒C	☒C	Majority of streamside area with depressions able to pond water < 3 inches deep

15. **Wetland Presence – streamside area metric (skip for Tidal Marsh Streams)**
Consider for the Left Bank (LB) and the Right Bank (RB). Do not consider wetlands outside of the streamside area or within the normal wetted perimeter of assessment reach.

LB	RB	
☐Y	☐Y	Are wetlands present in the streamside area?
☒N	☒N	

16. **Baseflow Contributors – assessment reach metric (skip for Size 4 streams and Tidal Marsh Streams)**
Check all contributors within the assessment reach or within view of <u>and</u> draining to the assessment reach.
☒A Streams and/or springs (jurisdictional discharges)
☐B Ponds (include wet detention basins; do not include sediment basins or dry detention basins)
☐C Obstruction passing flow during low-flow periods within the assessment area (beaver dam, leaky dam, bottom-release dam, weir)
☐D Evidence of bank seepage or sweating (iron in water indicates seepage)
☐E Stream bed or bank soil reduced (dig through deposited sediment if present)
☐F None of the above

17. **Baseflow Detractors – assessment area metric (skip for Tidal Marsh Streams)**
Check all that apply.
☐A Evidence of substantial water withdrawals from the assessment reach (includes areas excavated for pump installation)
☐B Obstruction not passing flow during low-flow periods affecting the assessment reach (ex: watertight dam, sediment deposit)
☐C Urban stream (≥ 24% impervious surface for watershed)
☐D Evidence that the streamside area has been modified resulting in accelerated drainage into the assessment reach
☐E Assessment reach relocated to valley edge
☒F None of the above

18. **Shading – assessment reach metric (skip for Tidal Marsh Streams)**
Consider aspect. Consider "leaf-on" condition.
☐A Stream shading is appropriate for stream category (may include gaps associated with natural processes)
☐B Degraded (example: scattered trees)
☒C Stream shading is gone or largely absent

19. **Buffer Width – streamside area metric (skip for Tidal Marsh Streams)**
Consider "vegetated buffer" and "wooded buffer" separately for left bank (LB) and right bank (RB) starting at the top of bank out to the first break.

Vegetated LB	Vegetated RB	Wooded LB	Wooded RB	
☐A	☐A	☐A	☐A	≥ 100 feet wide <u>or</u> extends to the edge of the watershed
☐B	☐B	☐B	☐B	From 50 to < 100 feet wide
☐C	☐C	☐C	☐C	From 30 to < 50 feet wide
☐D	☐D	☐D	☐D	From 10 to < 30 feet wide
☒E	☒E	☒E	☒E	< 10 feet wide <u>or</u> no trees

20. **Buffer Structure – streamside area metric (skip for Tidal Marsh Streams)**
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Vegetated" Buffer Width).

LB	RB	
☐A	☐A	Mature forest
☐B	☐B	Non-mature woody vegetation <u>or</u> modified vegetation structure
☐C	☐C	Herbaceous vegetation with or without a strip of trees < 10 feet wide
☐D	☐D	Maintained shrubs
☒E	☒E	Little or no vegetation

21. **Buffer Stressors – streamside area metric (skip for Tidal Marsh Streams)**
Check all appropriate boxes for left bank (LB) and right bank (RB). Indicate if listed stressor abuts stream (Abuts), does not abut but is within 30 feet of stream (< 30 feet), or is between 30 to 50 feet of stream (30-50 feet).
If none of the following stressors occurs on either bank, check here and skip to Metric 22: ☐

Abuts LB	Abuts RB	< 30 feet LB	< 30 feet RB	30-50 feet LB	30-50 feet RB	
☒A	☒A	☐A	☐A	☐A	☐A	Row crops
☐B	☐B	☐B	☐B	☐B	☐B	Maintained turf
☐C	☐C	☐C	☐C	☐C	☐C	Pasture (no livestock)/commercial horticulture
☐D	☐D	☐D	☐D	☐D	☐D	Pasture (active livestock use)

22. **Stem Density – streamside area metric (skip for Tidal Marsh Streams)**
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Wooded" Buffer Width).

LB	RB	
☐A	☐A	Medium to high stem density
☐B	☐B	Low stem density
☒C	☒C	No wooded riparian buffer <u>or</u> predominantly herbaceous species <u>or</u> bare ground

23. **Continuity of Vegetated Buffer – streamside area metric (skip for Tidal Marsh Streams)**
Consider whether vegetated buffer is continuous along stream (parallel). Breaks are areas lacking vegetation > 10 feet wide.

LB	RB	
☐A	☐A	The total length of buffer breaks is < 25 percent.
☐B	☐B	The total length of buffer breaks is between 25 and 50 percent.
☒C	☒C	The total length of buffer breaks is > 50 percent.

24. **Vegetative Composition – streamside area metric (skip for Tidal Marsh Streams)**
Evaluate the dominant vegetation within 100 feet of each bank or to the edge of the watershed (whichever comes first) as it contributes to assessment reach habitat.

LB	RB	
☐A	☐A	Vegetation is close to undisturbed in species present and their proportions. Lower strata composed of native species, with non-native invasive species absent or sparse.
☐B	☐B	Vegetation indicates disturbance in terms of species diversity or proportions, but is still largely composed of native species. This may include communities of weedy native species that develop after clear-cutting or clearing <u>or</u> communities with non-native invasive species present, but not dominant, over a large portion of the expected strata <u>or</u> communities missing understory but retaining canopy trees.
☒C	☒C	Vegetation is severely disturbed in terms of species diversity or proportions. Mature canopy is absent <u>or</u> communities with non-native invasive species dominant over a large portion of expected strata <u>or</u> communities composed of planted stands of non-characteristic species <u>or</u> communities inappropriately composed of a single species <u>or</u> no vegetation.

25. **Conductivity – assessment reach metric (skip for all Coastal Plain streams)**
25a. ☐Yes ☒No Was conductivity measurement recorded?
If No, select one of the following reasons. ☐No Water ☐Other: ______________________________

25b. Check the box corresponding to the conductivity measurement (units of microsiemens per centimeter).
☐A < 46 ☐B 46 to < 67 ☐C 67 to < 79 ☐D 79 to < 230 ☐E ≥ 230

Notes/Sketch:

Draft NC SAM Stream Rating Sheet
Accompanies User Manual Version 2.1

Stream Site Name	Hornpipe Branch Tributaries UT1	Date of Assessment	12-4-2019
Stream Category	Ia1	Assessor Name/Organization	Kyle Obermiller - WLS

Notes of Field Assessment Form (Y/N)	NO
Presence of regulatory considerations (Y/N)	NO
Additional stream information/supplementary measurements included (Y/N)	NO
NC SAM feature type (perennial, intermittent, Tidal Marsh Stream)	Perennial

Function Class Rating Summary	**USACE/ All Streams**	**NCDWR Intermittent**
(1) Hydrology	**LOW**	
(2) Baseflow	**HIGH**	
(2) Flood Flow	**LOW**	
(3) Streamside Area Attenuation	**LOW**	
(4) Floodplain Access	**LOW**	
(4) Wooded Riparian Buffer	**LOW**	
(4) Microtopography	**LOW**	
(3) Stream Stability	**LOW**	
(4) Channel Stability	**LOW**	
(4) Sediment Transport	**LOW**	
(4) Stream Geomorphology	**LOW**	
(2) Stream/Intertidal Zone Interaction	NA	
(2) Longitudinal Tidal Flow	NA	
(2) Tidal Marsh Stream Stability	NA	
(3) Tidal Marsh Channel Stability	NA	
(3) Tidal Marsh Stream Geomorphology	NA	
(1) Water Quality	**LOW**	
(2) Baseflow	**HIGH**	
(2) Streamside Area Vegetation	**LOW**	
(3) Upland Pollutant Filtration	**LOW**	
(3) Thermoregulation	**LOW**	
(2) Indicators of Stressors	**YES**	
(2) Aquatic Life Tolerance	**MEDIUM**	
(2) Intertidal Zone Filtration	NA	
(1) Habitat	**LOW**	
(2) In-stream Habitat	**LOW**	
(3) Baseflow	**HIGH**	
(3) Substrate	**LOW**	
(3) Stream Stability	**LOW**	
(3) In-stream Habitat	**LOW**	
(2) Stream-side Habitat	**LOW**	
(3) Stream-side Habitat	**LOW**	
(3) Thermoregulation	**LOW**	
(2) Tidal Marsh In-stream Habitat	NA	
(3) Flow Restriction	NA	
(3) Tidal Marsh Stream Stability	NA	
(4) Tidal Marsh Channel Stability	NA	
(4) Tidal Marsh Stream Geomorphology	NA	
(3) Tidal Marsh In-stream Habitat	NA	
(2) Intertidal Zone	NA	
Overall	**LOW**	

NC SAM FIELD ASSESSMENT FORM
Accompanies User Manual Version 2.1

USACE AID #: NCDWR #:

INSTRUCTIONS: Attach a sketch of the assessment area and photographs. Attach a copy of the USGS 7.5-minute topographic quadrangle, and circle the location of the stream reach under evaluation. If multiple stream reaches will be evaluated on the same property, identify and number all reaches on the attached map, and include a separate form for each reach. See the NC SAM User Manual for detailed descriptions and explanations of requested information. Record in the "Notes/Sketch" section if supplementary measurements were performed. See the NC SAM User Manual for examples of additional measurements that may be relevant.

NOTE EVIDENCE OF STRESSORS AFFECTING THE ASSESSMENT AREA (do not need to be within the assessment area).

PROJECT/SITE INFORMATION:

1. Project name (if any): Hornpipe Branch Tributaries UT2 2. Date of evaluation: 12-4-2019
3. Applicant/owner name: Water & Land Solutions 4. Assessor name/organization: Kyle Obermiller - WLS
5. County: Lenoir 6. Nearest named water body on USGS 7.5-minute quad: Hornpipe Branch
7. River basin: Neuse
8. Site coordinates (decimal degrees, at lower end of assessment reach): 35.13352, -77.65464

STREAM INFORMATION: (depth and width can be approximations)

9. Site number (show on attached map): UT2 10. Length of assessment reach evaluated (feet): 760
11. Channel depth from bed (in riffle, if present) to top of bank (feet): 4 ☐Unable to assess channel depth.
12. Channel width at top of bank (feet): 4 13. Is assessment reach a swamp steam? ☐Yes ☒No
14. Feature type: ☐Perennial flow ☒Intermittent flow ☐Tidal Marsh Stream

STREAM CATEGORY INFORMATION:

15. NC SAM Zone: ☐ Mountains (M) ☐ Piedmont (P) ☒ Inner Coastal Plain (I) ☐ Outer Coastal Plain (O)

16. Estimated geomorphic valley shape (**skip for Tidal Marsh Stream**):

☒A 
(more sinuous stream, flatter valley slope)

☐B 
(less sinuous stream, steeper valley slope)

17. Watershed size: (**skip for Tidal Marsh Stream**) ☒Size 1 (< 0.1 mi^2) ☐Size 2 (0.1 to < 0.5 mi^2) ☐Size 3 (0.5 to < 5 mi^2) ☐Size 4 (≥ 5 mi^2)

ADDITIONAL INFORMATION:

18. Were regulatory considerations evaluated? ☒Yes ☐No If Yes, check all that apply to the assessment area.
- ☐Section 10 water
- ☐Classified Trout Waters
- ☐Water Supply Watershed (☐I ☐II ☐III ☐IV ☐V)
- ☐Essential Fish Habitat
- ☐Primary Nursery Area
- ☐ High Quality Waters/Outstanding Resource Waters
- ☐Publicly owned property
- ☐NCDWR Riparian buffer rule in effect
- ☐Nutrient Sensitive Waters
- ☐Anadromous fish
- ☐303(d) List
- ☐CAMA Area of Environmental Concern (AEC)
- ☐Documented presence of a federal and/or state listed protected species within the assessment area.
  List species:
- ☐Designated Critical Habitat (list species)

19. Are additional stream information/supplementary measurements included in "Notes/Sketch" section or attached? ☐Yes ☒No

1. Channel Water – assessment reach metric (skip for Size 1 streams and Tidal Marsh Streams)
- ☒A Water throughout assessment reach.
- ☐B No flow, water in pools only.
- ☐C No water in assessment reach.

2. Evidence of Flow Restriction – assessment reach metric
- ☐A At least 10% of assessment reach in-stream habitat or riffle-pool sequence is severely affected by a flow restriction <u>or</u> fill to the point of obstructing flow <u>or</u> a channel choked with aquatic macrophytes <u>or</u> ponded water <u>or</u> impoundment on flood or ebb within the assessment reach (examples: undersized or perched culverts, causeways that constrict the channel, tidal gates, debris jams, beaver dams).
- ☒B Not A

3. Feature Pattern – assessment reach metric
- ☒A A majority of the assessment reach has altered pattern (examples: straightening, modification above or below culvert).
- ☐B Not A

4. Feature Longitudinal Profile – assessment reach metric
- ☒A Majority of assessment reach has a substantially altered stream profile (examples: channel down-cutting, existing damming, over widening, active aggradation, dredging, and excavation where appropriate channel profile has not reformed from any of these disturbances).
- ☐B Not A

5. Signs of Active Instability – assessment reach metric

Consider only current instability, not past events from which the stream has currently recovered. Examples of instability include active bank failure, active channel down-cutting (head-cut), active widening, and artificial hardening (such as concrete, gabion, rip-rap).
- ☐A < 10% of channel unstable
- ☐B 10 to 25% of channel unstable
- ☒C > 25% of channel unstable

6. **Streamside Area Interaction – streamside area metric**
Consider for the Left Bank (LB) and the Right Bank (RB).

LB	RB	
☐A	☐A	Little or no evidence of conditions that adversely affect reference interaction
☐B	☐B	Moderate evidence of conditions (examples: berms, levees, down-cutting, aggradation, dredging) that adversely affect reference interaction (examples: limited streamside area access, disruption of flood flows through streamside area, leaky or intermittent bulkheads, causeways with floodplain constriction, minor ditching [including mosquito ditching])
☒C	☒C	Extensive evidence of conditions that adversely affect reference interaction (little to no floodplain/intertidal zone access [examples: causeways with floodplain and channel constriction, bulkheads, retaining walls, fill, stream incision, disruption of flood flows through streamside area] or too much floodplain/intertidal zone access [examples: impoundments, intensive mosquito ditching]) or floodplain/intertidal zone unnaturally absent or assessment reach is a man-made feature on an interstream divide

7. **Water Quality Stressors – assessment reach/intertidal zone metric**
Check all that apply.
- ☐A Discolored water in stream or intertidal zone (milky white, blue, unnatural water discoloration, oil sheen, stream foam)
- ☐B Excessive sedimentation (burying of stream features or intertidal zone)
- ☒C Noticeable evidence of pollutant discharges entering the assessment reach and causing a water quality problem
- ☐D Odor (not including natural sulfide odors)
- ☐E Current published or collected data indicating degraded water quality in the assessment reach. Cite source in “Notes/Sketch” section.
- ☐F Livestock with access to stream or intertidal zone
- ☐G Excessive algae in stream or intertidal zone
- ☐H Degraded marsh vegetation in the intertidal zone (removal, burning, regular mowing, destruction, etc)
- ☒I Other: ____________________ (explain in “Notes/Sketch” section)
- ☐J Little to no stressors

8. **Recent Weather – watershed metric (skip for Tidal Marsh Streams)**
For Size 1 or 2 streams, D1 drought or higher is considered a drought; for Size 3 or 4 streams, D2 drought or higher is considered a drought.
- ☐A Drought conditions and no rainfall or rainfall not exceeding 1 inch within the last 48 hours
- ☐B Drought conditions and rainfall exceeding 1 inch within the last 48 hours
- ☒C No drought conditions

9. **Large or Dangerous Stream – assessment reach metric**
☐Yes ☒No Is stream is too large or dangerous to assess? If Yes, skip to Metric 13 (Streamside Area Ground Surface Condition).

10. **Natural In-stream Habitat Types – assessment reach metric**
10a. ☒Yes ☐No Degraded in-stream habitat over majority of the assessment reach (examples of stressors include excessive sedimentation, mining, excavation, in-stream hardening [for example, rip-rap], recent dredging, and snagging) **(evaluate for Size 4 Coastal Plain streams only, then skip to Metric 12)**

10b. **Check all that occur** (occurs if > 5% coverage of assessment reach) **(skip for Size 4 Coastal Plain streams)**
- ☐A Multiple aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
- ☐B Multiple sticks and/or leaf packs and/or emergent vegetation
- ☐C Multiple snags and logs (including lap trees)
- ☐D 5% undercut banks and/or root mats and/or roots in banks extend to the normal wetted perimeter
- ☒E Little or no habitat

Check for Tidal Marsh Streams Only
- ☐F 5% oysters or other natural hard bottoms
- ☐G Submerged aquatic vegetation
- ☐H Low-tide refugia (pools)
- ☐I Sand bottom
- ☐J 5% vertical bank along the marsh
- ☐K Little or no habitat

**********************************REMAINING QUESTIONS ARE NOT APPLICABLE FOR TIDAL MARSH STREAMS*****************************

11. **Bedform and Substrate – assessment reach metric (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**

11a. ☒Yes ☐No Is assessment reach in a natural sand-bed stream? **(skip for Coastal Plain streams)**

11b. Bedform evaluated. **Check the appropriate box(es).**
- ☐A Riffle-run section **(evaluate 11c)**
- ☐B Pool-glide section **(evaluate 11d)**
- ☒C Natural bedform absent **(skip to Metric 12, Aquatic Life)**

11c. In riffle sections, check all that occur below the normal wetted perimeter of the assessment reach – whether or not submerged. **Check at least one box in each row (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**. Not Present (NP) = absent, Rare (R) = present but ≤ 10%, Common (C) = > 10-40%, Abundant (A) = > 40-70%, Predominant (P) = > 70%. Cumulative percentages should not exceed 100% for each assessment reach.

NP	R	C	A	P	
☐	☐	☐	☐	☐	Bedrock/saprolite
☐	☐	☐	☐	☐	Boulder (256 – 4096 mm)
☐	☐	☐	☐	☐	Cobble (64 – 256 mm)
☐	☐	☐	☐	☐	Gravel (2 – 64 mm)
☐	☐	☐	☐	☐	Sand (.062 – 2 mm)
☐	☐	☐	☐	☐	Silt/clay (< 0.062 mm)
☐	☐	☐	☐	☐	Detritus
☐	☐	☐	☐	☐	Artificial (rip-rap, concrete, etc.)

11d. ☐Yes ☐No Are pools filled with sediment? (**skip for Size 4 Coastal Plain streams and Tidal Marsh Streams**)

12. Aquatic Life – assessment reach metric (skip for Tidal Marsh Streams)

12a. ☒Yes ☐No Was an in-stream aquatic life assessment performed as described in the User Manual?
If No, select one of the following reasons and skip to Metric 13. ☐No Water ☐Other: ____________________

12b. ☒Yes ☐No Are aquatic organisms present in the assessment reach (look in riffles, pools, then snags)? If Yes, check all that apply. If No, skip to Metric 13.

1	>1	Numbers over columns refer to "individuals" for Size 1 and 2 streams and "taxa" for Size 3 and 4 streams.
☐	☐	Adult frogs
☐	☐	Aquatic reptiles
☐	☐	Aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
☐	☐	Beetles
☐	☐	Caddisfly larvae (T)
☐	☐	Asian clam (*Corbicula*)
☐	☐	Crustacean (isopod/amphipod/crayfish/shrimp)
☐	☐	Damselfly and dragonfly larvae
☐	☐	Dipterans
☐	☐	Mayfly larvae (E)
☐	☐	Megaloptera (alderfly, fishfly, dobsonfly larvae)
☐	☒	Midges/mosquito larvae
☐	☐	Mosquito fish (*Gambusia*) or mud minnows (*Umbra pygmaea)*
☐	☐	Mussels/Clams (not *Corbicula*)
☐	☒	Other fish
☐	☒	Salamanders/tadpoles
☐	☐	Snails
☐	☐	Stonefly larvae (P)
☐	☐	Tipulid larvae
☐	☐	Worms/leeches

13. Streamside Area Ground Surface Condition – streamside area metric (skip for Tidal Marsh Streams and B valley types)
Consider for the Left Bank (LB) and the Right Bank (RB). Consider storage capacity with regard to both overbank flow and upland runoff.

LB	RB	
☐A	☐A	Little or no alteration to water storage capacity over a majority of the streamside area
☐B	☐B	Moderate alteration to water storage capacity over a majority of the streamside area
☒C	☒C	Severe alteration to water storage capacity over a majority of the streamside area (examples: ditches, fill, soil compaction, livestock disturbance, buildings, man-made levees, drainage pipes)

14. Streamside Area Water Storage – streamside area metric (skip for Size 1 streams, Tidal Marsh Streams, and B valley types)
Consider for the Left Bank (LB) and the Right Bank (RB) of the streamside area.

LB	RB	
☐A	☐A	Majority of streamside area with depressions able to pond water ≥ 6 inches deep
☐B	☐B	Majority of streamside area with depressions able to pond water 3 to 6 inches deep
☒C	☒C	Majority of streamside area with depressions able to pond water < 3 inches deep

15. Wetland Presence – streamside area metric (skip for Tidal Marsh Streams)
Consider for the Left Bank (LB) and the Right Bank (RB). Do not consider wetlands outside of the streamside area or within the normal wetted perimeter of assessment reach.

LB	RB	
☐Y	☐Y	Are wetlands present in the streamside area?
☒N	☒N	

16. Baseflow Contributors – assessment reach metric (skip for Size 4 streams and Tidal Marsh Streams)
Check all contributors within the assessment reach or within view of <u>and</u> draining to the assessment reach.

☒A Streams and/or springs (jurisdictional discharges)
☐B Ponds (include wet detention basins; do not include sediment basins or dry detention basins)
☐C Obstruction passing flow during low-flow periods within the assessment area (beaver dam, leaky dam, bottom-release dam, weir)
☐D Evidence of bank seepage or sweating (iron in water indicates seepage)
☐E Stream bed or bank soil reduced (dig through deposited sediment if present)
☐F None of the above

17. Baseflow Detractors – assessment area metric (skip for Tidal Marsh Streams)
Check all that apply.

☐A Evidence of substantial water withdrawals from the assessment reach (includes areas excavated for pump installation)
☐B Obstruction not passing flow during low-flow periods affecting the assessment reach (ex: watertight dam, sediment deposit)
☐C Urban stream (≥ 24% impervious surface for watershed)
☐D Evidence that the streamside area has been modified resulting in accelerated drainage into the assessment reach
☐E Assessment reach relocated to valley edge
☒F None of the above

18. Shading – assessment reach metric (skip for Tidal Marsh Streams)
Consider aspect. Consider "leaf-on" condition.

☐A Stream shading is appropriate for stream category (may include gaps associated with natural processes)
☐B Degraded (example: scattered trees)
☒C Stream shading is gone or largely absent

19. Buffer Width – streamside area metric (skip for Tidal Marsh Streams)
Consider "vegetated buffer" and "wooded buffer" separately for left bank (LB) and right bank (RB) starting at the top of bank out to the first break.

Vegetated LB	Vegetated RB	Wooded LB	Wooded RB	
☐A	☐A	☐A	☐A	≥ 100 feet wide or extends to the edge of the watershed
☐B	☐B	☐B	☐B	From 50 to < 100 feet wide
☐C	☐C	☐C	☐C	From 30 to < 50 feet wide
☐D	☐D	☐D	☐D	From 10 to < 30 feet wide
☒E	☒E	☒E	☒E	< 10 feet wide or no trees

20. Buffer Structure – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Vegetated" Buffer Width).

LB	RB	
☐A	☐A	Mature forest
☐B	☐B	Non-mature woody vegetation or modified vegetation structure
☐C	☐C	Herbaceous vegetation with or without a strip of trees < 10 feet wide
☐D	☐D	Maintained shrubs
☒E	☒E	Little or no vegetation

21. Buffer Stressors – streamside area metric (skip for Tidal Marsh Streams)
Check all appropriate boxes for left bank (LB) and right bank (RB). Indicate if listed stressor abuts stream (Abuts), does not abut but is within 30 feet of stream (< 30 feet), or is between 30 to 50 feet of stream (30-50 feet).
If none of the following stressors occurs on either bank, check here and skip to Metric 22: ☐

Abuts LB	Abuts RB	< 30 feet LB	< 30 feet RB	30-50 feet LB	30-50 feet RB	
☒A	☒A	☐A	☐A	☐A	☐A	Row crops
☐B	☐B	☐B	☐B	☐B	☐B	Maintained turf
☐C	☐C	☐C	☐C	☐C	☐C	Pasture (no livestock)/commercial horticulture
☐D	☐D	☐D	☐D	☐D	☐D	Pasture (active livestock use)

22. Stem Density – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Wooded" Buffer Width).

LB	RB	
☐A	☐A	Medium to high stem density
☐B	☐B	Low stem density
☒C	☒C	No wooded riparian buffer or predominantly herbaceous species or bare ground

23. Continuity of Vegetated Buffer – streamside area metric (skip for Tidal Marsh Streams)
Consider whether vegetated buffer is continuous along stream (parallel). Breaks are areas lacking vegetation > 10 feet wide.

LB	RB	
☐A	☐A	The total length of buffer breaks is < 25 percent.
☐B	☐B	The total length of buffer breaks is between 25 and 50 percent.
☒C	☒C	The total length of buffer breaks is > 50 percent.

24. Vegetative Composition – streamside area metric (skip for Tidal Marsh Streams)
Evaluate the dominant vegetation within 100 feet of each bank or to the edge of the watershed (whichever comes first) as it contributes to assessment reach habitat.

LB	RB	
☐A	☐A	Vegetation is close to undisturbed in species present and their proportions. Lower strata composed of native species, with non-native invasive species absent or sparse.
☐B	☐B	Vegetation indicates disturbance in terms of species diversity or proportions, but is still largely composed of native species. This may include communities of weedy native species that develop after clear-cutting or clearing or communities with non-native invasive species present, but not dominant, over a large portion of the expected strata or communities missing understory but retaining canopy trees.
☒C	☒C	Vegetation is severely disturbed in terms of species diversity or proportions. Mature canopy is absent or communities with non-native invasive species dominant over a large portion of expected strata or communities composed of planted stands of non-characteristic species or communities inappropriately composed of a single species or no vegetation.

25. Conductivity – assessment reach metric (skip for all Coastal Plain streams)
25a. ☐Yes ☒No Was conductivity measurement recorded?
If No, select one of the following reasons. ☐No Water ☐Other: ______________________________

25b. Check the box corresponding to the conductivity measurement (units of microsiemens per centimeter).
☐A < 46 ☐B 46 to < 67 ☐C 67 to < 79 ☐D 79 to < 230 ☐E ≥ 230

Notes/Sketch:

Draft NC SAM Stream Rating Sheet
Accompanies User Manual Version 2.1

Stream Site Name	Hornpipe Branch Tributaries UT2	Date of Assessment	12-4-2019
Stream Category	Ia1	Assessor Name/Organization	Kyle Obermiller - WLS

Notes of Field Assessment Form (Y/N)	NO
Presence of regulatory considerations (Y/N)	NO
Additional stream information/supplementary measurements included (Y/N)	NO
NC SAM feature type (perennial, intermittent, Tidal Marsh Stream)	Intermittent

Function Class Rating Summary	**USACE/ All Streams**	**NCDWR Intermittent**
(1) Hydrology	**LOW**	**LOW**
(2) Baseflow	**HIGH**	**HIGH**
(2) Flood Flow	**LOW**	**LOW**
(3) Streamside Area Attenuation	**LOW**	**LOW**
(4) Floodplain Access	**LOW**	**LOW**
(4) Wooded Riparian Buffer	**LOW**	**LOW**
(4) Microtopography	**LOW**	**LOW**
(3) Stream Stability	**LOW**	**LOW**
(4) Channel Stability	**LOW**	**LOW**
(4) Sediment Transport	**LOW**	**LOW**
(4) Stream Geomorphology	**LOW**	**LOW**
(2) Stream/Intertidal Zone Interaction	NA	NA
(2) Longitudinal Tidal Flow	NA	NA
(2) Tidal Marsh Stream Stability	NA	NA
(3) Tidal Marsh Channel Stability	NA	NA
(3) Tidal Marsh Stream Geomorphology	NA	NA
(1) Water Quality	**LOW**	**LOW**
(2) Baseflow	**HIGH**	**HIGH**
(2) Streamside Area Vegetation	**LOW**	**LOW**
(3) Upland Pollutant Filtration	**LOW**	**LOW**
(3) Thermoregulation	**LOW**	**LOW**
(2) Indicators of Stressors	**YES**	**YES**
(2) Aquatic Life Tolerance	**MEDIUM**	**NA**
(2) Intertidal Zone Filtration	NA	NA
(1) Habitat	**LOW**	**LOW**
(2) In-stream Habitat	**LOW**	**LOW**
(3) Baseflow	**HIGH**	**HIGH**
(3) Substrate	**LOW**	**LOW**
(3) Stream Stability	**LOW**	**LOW**
(3) In-stream Habitat	**LOW**	**LOW**
(2) Stream-side Habitat	**LOW**	**LOW**
(3) Stream-side Habitat	**LOW**	**LOW**
(3) Thermoregulation	**LOW**	**LOW**
(2) Tidal Marsh In-stream Habitat	NA	NA
(3) Flow Restriction	NA	NA
(3) Tidal Marsh Stream Stability	NA	NA
(4) Tidal Marsh Channel Stability	NA	NA
(4) Tidal Marsh Stream Geomorphology	NA	NA
(3) Tidal Marsh In-stream Habitat	NA	NA
(2) Intertidal Zone	NA	NA
Overall	**LOW**	**LOW**

NC WAM FIELD ASSESSMENT RESULTS
Accompanies User Manual Version 5.0

USACE AID #		NCDWR#	
Project Name	Hornpipe Branch Tributaries Mitigation Project	Date of Evaluation	12/4/2019
Applicant/Owner Name	Water & Land Solutions	Wetland Site Name	WA
Wetland Type	Non-Tidal Freshwater Marsh	Assessor Name/Organization	Kyle Obermiller - WLS
Level III Ecoregion	Southeastern Plains	Nearest Named Water Body	Hornpipe Branch
River Basin	Neuse	USGS 8-Digit Catalogue Unit	03020202
County	Lenoir	NCDWR Region	Washington
☐ Yes ☒ No	Precipitation within 48 hrs?	Latitude/Longitude (deci-degrees)	35.13427, -77.65502

Evidence of stressors affecting the assessment area (may not be within the assessment area)
Please circle and/or make note on the last page if evidence of stressors is apparent. Consider departure from reference, if appropriate, in recent past (for instance, within 10 years). Noteworthy stressors include, but are not limited to the following.
- Hydrological modifications (examples: ditches, dams, beaver dams, dikes, berms, ponds, etc.)
- Surface and sub-surface discharges into the wetland (examples: discharges containing obvious pollutants, presence of nearby septic tanks, underground storage tanks (USTs), hog lagoons, etc.)
- Signs of vegetation stress (examples: vegetation mortality, insect damage, disease, storm damage, salt intrusion, etc.)
- Habitat/plant community alteration (examples: mowing, clear-cutting, exotics, etc.)

Is the assessment area intensively managed? ☒ Yes ☐ No

Regulatory Considerations - Were regulatory considerations evaluated? ☒Yes ☐No If Yes, check all that apply to the assessment area.
☐ Anadromous fish
☐ Federally protected species or State endangered or threatened species
☐ NCDWR riparian buffer rule in effect
☐ Abuts a Primary Nursery Area (PNA)
☐ Publicly owned property
☐ N.C. Division of Coastal Management Area of Environmental Concern (AEC) (including buffer)
☐ Abuts a stream with a NCDWQ classification of SA or supplemental classifications of HQW, ORW, or Trout
☐ Designated NCNHP reference community
☐ Abuts a 303(d)-listed stream or a tributary to a 303(d)-listed stream

What type of natural stream is associated with the wetland, if any? (check all that apply)
☒ Blackwater
☐ Brownwater
☐ Tidal (if tidal, check one of the following boxes) ☐ Lunar ☐ Wind ☐ Both

Is the assessment area on a coastal island? ☐ Yes ☐ No

Is the assessment area's surface water storage capacity or duration substantially altered by beaver? ☐ Yes ☒ No
Does the assessment area experience overbank flooding during normal rainfall conditions? ☐ Yes ☒ No

1. Ground Surface Condition/Vegetation Condition – assessment area condition metric

Check a box in each column. Consider alteration to the ground surface (GS) in the assessment area and vegetation structure (VS) in the assessment area. Compare to reference wetland if applicable (see User Manual). If a reference is not applicable, then rate the assessment area based on evidence an effect.

GS	VS	
☐A	☐A	Not severely altered
☒B	☒B	Severely altered over a majority of the assessment area (ground surface alteration examples: vehicle tracks, excessive sedimentation, fire-plow lanes, skidder tracks, bedding, fill, soil compaction, obvious pollutants) (vegetation structure alteration examples: mechanical disturbance, herbicides, salt intrusion [where appropriate], exotic species, grazing, less diversity [if appropriate], hydrologic alteration)

2. Surface and Sub-Surface Storage Capacity and Duration – assessment area condition metric

Check a box in each column. Consider surface storage capacity and duration (Surf) and sub-surface storage capacity and duration (Sub). Consider both increase and decrease in hydrology. A ditch ≤ 1 foot deep is considered to affect surface water only, while a ditch > 1 foot deep is expected to affect both surface and sub-surface water. Consider tidal flooding regime, if applicable.

Surf	Sub	
☐A	☐A	Water storage capacity and duration are not altered.
☐B	☐B	Water storage capacity or duration are altered, but not substantially (typically, not sufficient to change vegetation).
☒C	☒C	Water storage capacity or duration are substantially altered (typically, alteration sufficient to result in vegetation change) (examples: draining, flooding, soil compaction, filling, excessive sedimentation, underground utility lines).

3. Water Storage/Surface Relief – assessment area/wetland type condition metric (skip for all marshes)

Check a box in each column. Select the appropriate storage for the assessment area (AA) and the wetland type (WT).

	AA	WT	
3a.	☒A	☒A	Majority of wetland with depressions able to pond water > 1 deep
	☐B	☐B	Majority of wetland with depressions able to pond water 6 inches to 1 foot deep
	☐C	☐C	Majority of wetland with depressions able to pond water 3 to 6 inches deep
	☐D	☐D	Depressions able to pond water < 3 inches deep

3b. ☐A Evidence that maximum depth of inundation is greater than 2 feet
☒B Evidence that maximum depth of inundation is between 1 and 2 feet
☐C Evidence that maximum depth of inundation is less than 1 foot

4. Soil Texture/Structure – assessment area condition metric (skip for all marshes)

Check a box from each of the three soil property groups below. Dig soil profile in the dominant assessment area landscape feature. Make soil observations within the top 12 inches. Use most recent National Technical Committee for Hydric Soils guidance for regional indicators.

4a. ☒A Sandy soil
☐B Loamy or clayey soils exhibiting redoximorphic features (concentrations, depletions, or rhizospheres)
☐C Loamy or clayey soils not exhibiting redoximorphic features
☐D Loamy or clayey gleyed soil
☐E Histosol or histic epipedon

4b. ☒A Soil ribbon < 1 inch
☐B Soil ribbon ≥ 1 inch

4c. ☒A No peat or muck presence
☐B A peat or muck presence

5. Discharge into Wetland – opportunity metric

Check a box in each column. Consider surface pollutants or discharges (Surf) and sub-surface pollutants or discharges (Sub). Examples of sub-surface discharges include presence of nearby septic tank, underground storage tank (UST), etc.

Surf	Sub	
☐A	☒A	Little or no evidence of pollutants or discharges entering the assessment area
☒B	☐B	Noticeable evidence of pollutants or discharges entering the wetland and stressing, but not overwhelming the treatment capacity of the assessment area
☐C	☐C	Noticeable evidence of pollutants or discharges (pathogen, particulate, or soluble) entering the assessment area and potentially overwhelming the treatment capacity of the wetland (water discoloration, dead vegetation, excessive sedimentation, odor)

6. Land Use – opportunity metric (skip for non-riparian wetlands)

Check all that apply (at least one box in each column). Evaluation involves a GIS effort with field adjustment. Consider sources draining to assessment area within entire upstream watershed (WS), within 5 miles <u>and</u> within the watershed draining to the assessment area (5M), <u>and</u> within 2 miles and within the watershed draining to the assessment area (2M).

WS	5M	2M	
☐A	☐A	☐A	≥ 10% impervious surfaces
☐B	☐B	☐B	Confined animal operations (or other local, concentrated source of pollutants
☐C	☐C	☐C	≥ 20% coverage of pasture
☒D	☐D	☐D	≥ 20% coverage of agricultural land (regularly plowed land)
☐E	☐E	☐E	≥ 20% coverage of maintained grass/herb
☐F	☐F	☐F	≥ 20% coverage of clear-cut land
☐G	☐G	☐G	Little or no opportunity to improve water quality. Lack of opportunity may result from little or no disturbance in the watershed <u>or</u> hydrologic alterations that prevent drainage <u>and/or</u> overbank flow from affecting the assessment area.

7. Wetland Acting as Vegetated Buffer – assessment area/wetland complex condition metric (skip for non-riparian wetlands)

7a. Is assessment area within 50 feet of a tributary or other open water?
☒Yes ☐No If Yes, continue to 7b. If No, skip to Metric 8.
Wetland buffer need only be present on one side of the water body. Make buffer judgment based on the average width of wetland. Record a note if a portion of the buffer has been removed or disturbed.

7b. How much of the first 50 feet from the bank is wetland? (Wetland buffer need only be present on one side of the .water body. Make buffer judgment based on the average width of wetland. Record a note if a portion of the buffer has been removed or disturbed.)
☐A ≥ 50 feet
☐B From 30 to < 50 feet
☒C From 15 to < 30 feet
☐D From 5 to < 15 feet
☐E < 5 feet <u>or</u> buffer bypassed by ditches

7c. Tributary width. If the tributary is anastomosed, combine widths of channels/braids for a total width.
☒≤ 15-feet wide ☐> 15-feet wide ☐ Other open water (no tributary present)

7d. Do roots of assessment area vegetation extend into the bank of the tributary/open water?
☒Yes ☐No

7e. Is stream or other open water sheltered or exposed?
☒Sheltered – adjacent open water with width < 2500 feet <u>and</u> no regular boat traffic.
☐Exposed – adjacent open water with width ≥ 2500 feet <u>or</u> regular boat traffic.

8. Wetland Width at the Assessment Area – wetland type/wetland complex condition metric (evaluate WT for all marshes and Estuarine Woody Wetland only; evaluate WC for Bottomland Hardwood Forest, Headwater Forest, and Riverine Swamp Forest only)

Check a box in each column for riverine wetlands only. Select the average width for the wetland type at the assessment area (WT) and the wetland complex at the assessment area (WC). See User Manual for WT and WC boundaries.

WT	WC	
☐A	☐A	≥ 100 feet
☐B	☐B	From 80 to < 100 feet
☒C	☒C	From 50 to < 80 feet
☐D	☐D	From 40 to < 50 feet
☐E	☐E	From 30 to < 40 feet
☐F	☐F	From 15 to < 30 feet
☐G	☐G	From 5 to < 15 feet
☐H	☐H	< 5 feet

9. **Inundation Duration – assessment area condition metric (skip for non-riparian wetlands)**

Answer for assessment area dominant landform.

☐A Evidence of short-duration inundation (< 7 consecutive days)
☐B Evidence of saturation, without evidence of inundation
☒C Evidence of long-duration inundation or very long-duration inundation (7 to 30 consecutive days or more)

10. **Indicators of Deposition – assessment area condition metric (skip for non-riparian wetlands and all marshes)**

Consider recent deposition only (no plant growth since deposition).

☐A Sediment deposition is not excessive, but at approximately natural levels.
☒B Sediment deposition is excessive, but not overwhelming the wetland.
☐C Sediment deposition is excessive and is overwhelming the wetland.

11. **Wetland Size – wetland type/wetland complex condition metric**

Check a box in each column. Involves a GIS effort with field adjustment. This metric evaluates three aspects of the wetland area: the size of the wetland type (WT), the size of the wetland complex (WC), and the size of the forested wetland (FW) (if applicable, see User Manual). See the User Manual for boundaries of these evaluation areas. If assessment area is clear-cut, select "K" for the FW column.

WT	WC	FW (if applicable)	
☐A	☐A	☐A	≥ 500 acres
☐B	☐B	☐B	From 100 to < 500 acres
☐C	☐C	☐C	From 50 to < 100 acres
☐D	☐D	☐D	From 25 to < 50 acres
☐E	☐E	☐E	From 10 to < 25 acres
☐F	☐F	☐F	From 5 to < 10 acres
☐G	☐G	☐G	From 1 to < 5 acres
☐H	☐H	☐H	From 0.5 to < 1 acre
☒I	☒I	☒I	From 0.1 to < 0.5 acre
☐J	☐J	☐J	From 0.01 to < 0.1 acre
☐K	☐K	☐K	< 0.01 acre <u>or</u> assessment area is clear-cut

12. **Wetland Intactness – wetland type condition metric (evaluate for Pocosins only)**

☐A Pocosin is the full extent (≥ 90%) of its natural landscape size.
☐B Pocosin type is < 90% of the full extent of its natural landscape size.

13. **Connectivity to Other Natural Areas – landscape condition metric**

13a. **Check appropriate box(es) (a box may be checked in each column).** Involves a GIS effort with field adjustment. This metric evaluates whether the wetland is well connected (Well) and/or loosely connected (Loosely) to the landscape patch, the contiguous naturally vegetated area and open water (if appropriate). Boundaries are formed by four-lane roads, regularly maintained utility line corridors the width of a four-lane road or wider, urban landscapes, maintained fields (pasture and agriculture), or open water > 300 feet wide.

Well	Loosely	
☐A	☐A	≥ 500 acres
☐B	☐B	From 100 to < 500 acres
☐C	☐C	From 50 to < 100 acres
☐D	☐D	From 10 to < 50 acres
☐E	☐E	< 10 acres
☒F	☒F	Wetland type has a poor or no connection to other natural habitats

13b. **Evaluate for marshes only**.

☒Yes ☐No Wetland type has a surface hydrology connection to open waters/stream or tidal wetlands.

14. **Edge Effect – wetland type condition metric (skip for all marshes and Estuarine Woody Wetland)**

May involve a GIS effort with field adjustment. Estimate distance from wetland type boundary to artificial edges. Artificial edges include non-forested areas ≥ 40 feet wide such as fields, development, roads, regularly maintained utility line corridors, and clear-cuts. Consider the eight main points of the compass. Artificial edge occurs within 150 feet in how many directions? If the assessment area is clear cut, select option "C."

☐A 0
☐B 1 to 4
☐C 5 to 8

15. **Vegetative Composition – assessment area condition metric (skip for all marshes and Pine Flat)**

☐A Vegetation is close to reference condition in species present and their proportions. Lower strata composed of appropriate species, with exotic plants absent or sparse within the assessment area.
☐B Vegetation is different from reference condition in species diversity or proportions, but still largely composed of native species characteristic of the wetland type. This may include communities of weedy native species that develop after clearcutting or clearing. It also includes communities with exotics present, but not dominant, over a large portion of the expected strata.
☐C Vegetation severely altered from reference in composition, <u>or</u> expected species are unnaturally absent (planted stands of non-characteristic species <u>or</u> at least one stratum inappropriately composed of a single species), <u>or</u> exotic species are dominant in at least one stratum.

16. **Vegetative Diversity – assessment area condition metric (evaluate for Non-tidal Freshwater Marsh only)**

☐A Vegetation diversity is high and is composed primarily of native species (< 10% cover of exotics).
☒B Vegetation diversity is low or has > 10% to 50% cover of exotics.
☐C Vegetation is dominated by exotic species (> 50 % cover of exotics).

17. Vegetative Structure – assessment area/wetland type condition metric

17a. Is vegetation present?

☒Yes ☐No If Yes, continue to 17b. If No, skip to Metric 18.

17b. Evaluate percent coverage of assessment area vegetation **for all marshes only**. Skip to 17c for non-marsh wetlands.

☒A ≥ 25% coverage of vegetation
☐B < 25% coverage of vegetation

17c. **Check a box in each column for each stratum**. Evaluate this portion of the metric **for non-marsh wetlands**. Consider structure in airspace above the assessment area (AA) and the wetland type (WT) separately.

	AA	WT	
Canopy	☐A	☐A	Canopy closed, or nearly closed, with natural gaps associated with natural processes
	☒B	☒B	Canopy present, but opened more than natural gaps
	☐C	☐C	Canopy sparse or absent
Mid-Story	☐A	☐A	Dense mid-story/sapling layer
	☐B	☐B	Moderate density mid-story/sapling layer
	☒C	☒C	Mid-story/sapling layer sparse or absent
Shrub	☐A	☐A	Dense shrub layer
	☐B	☐B	Moderate density shrub layer
	☒C	☒C	Shrub layer sparse or absent
Herb	☒A	☒A	Dense herb layer
	☐B	☐B	Moderate density herb layer
	☐C	☐C	Herb layer sparse or absent

18. Snags – wetland type condition metric (skip for all marshes)

☐A Large snags (more than one) are visible (> 12 inches DBH, or large relative to species present and landscape stability).
☒B Not A

19. Diameter Class Distribution – wetland type condition metric (skip for all marshes)

☐A Majority of canopy trees have stems > 6 inches in diameter at breast height (DBH); many large trees (> 12 inches DBH) are present.
☒B Majority of canopy trees have stems between 6 and 12 inches DBH, few are > 12 inch DBH.
☐C Majority of canopy trees are < 6 inches DBH or no trees.

20. Large Woody Debris – wetland type condition metric (skip for all marshes)

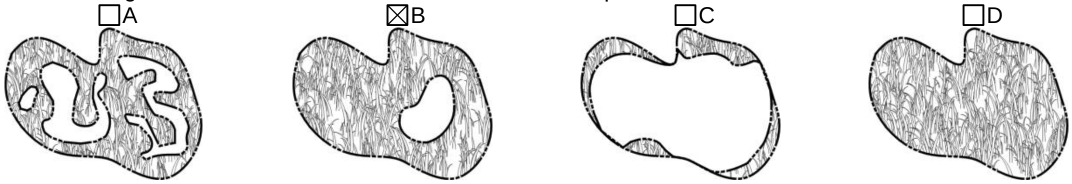
Include both natural debris and man-placed natural debris.

☐A Large logs (more than one) are visible (> 12 inches in diameter, or large relative to species present and landscape stability).
☒B Not A

21. Vegetation/Open Water Dispersion – wetland type/open water condition metric (evaluate for Non-Tidal Freshwater Marsh only)

Select the figure that best describes the amount of interspersion between vegetation and open water in the growing season. Patterned areas indicate vegetated areas, while solid white areas indicate open water.

☐A ☒B ☐C ☐D



22. Hydrologic Connectivity – assessment area condition metric (evaluate for riparian wetlands and Salt/Brackish Marsh only)

Examples of activities that may severely alter hydrologic connectivity include intensive ditching, fill, sedimentation, channelization, diversion, man-made berms, beaver dams, and stream incision. Documentation required if evaluated as B, C, or D.

☐A Overbank <u>and</u> overland flow are not severely altered in the assessment area.
☐B Overbank flow is severely altered in the assessment area.
☐C Overland flow is severely altered in the assessment area.
☒D Both overbank <u>and</u> overland flow are severely altered in the assessment area.

Notes

Area is an old farm pond, culvert failed and the pond has been transitioning into a wetland complex. Salix nigra present in canopy, mostly dominated by herbaceous vegetation with about 10% open water.

NC WAM Wetland Rating Sheet
Accompanies User Manual Version 5.0

Wetland Site Name	WA	Date of Assessment	12/4/2019
Wetland Type	Non-Tidal Freshwater Marsh	Assessor Name/Organization	Kyle Obermiller - WLS

Notes on Field Assessment Form (Y/N)	YES
Presence of regulatory considerations (Y/N)	NO
Wetland is intensively managed (Y/N)	YES
Assessment area is located within 50 feet of a natural tributary or other open water (Y/N)	YES
Assessment area is substantially altered by beaver (Y/N)	NO
Assessment area experiences overbank flooding during normal rainfall conditions (Y/N)	NO
Assessment area is on a coastal island (Y/N)	

Sub-function Rating Summary

Function	Sub-function	Metrics	Rating
Hydrology	Surface Storage and Retention	Condition	NA
	Sub-surface Storage and Retention	Condition	NA
Water Quality	Pathogen Change	Condition	NA
		Condition/Opportunity	NA
		Opportunity Presence (Y/N)	NA
	Particulate Change	Condition	NA
		Condition/Opportunity	NA
		Opportunity Presence (Y/N)	NA
	Soluble Change	Condition	NA
		Condition/Opportunity	NA
		Opportunity Presence (Y/N)	NA
	Physical Change	Condition	NA
		Condition/Opportunity	NA
		Opportunity Presence (Y/N)	NA
	Pollution Change	Condition	NA
		Condition/Opportunity	NA
		Opportunity Presence (Y/N)	NA
Habitat	Physical Structure	Condition	**LOW**
	Landscape Patch Structure	Condition	**LOW**
	Vegetation Composition	Condition	**MEDIUM**

Function Rating Summary

Function	Metrics	Rating
Hydrology	Condition	**LOW**
Water Quality	Condition	**LOW**
	Condition/Opportunity	**LOW**
	Opportunity Presence (Y/N)	**NO**
Habitat	Condition	**LOW**

Overall Wetland Rating **LOW**

Appendix 9 – WOTUS Information

U.S. ARMY CORPS OF ENGINEERS
WILMINGTON DISTRICT

Action Id. **SAW-2018-01762** County: **Lenoir** U.S.G.S. Quad: **NC- Deep Run**

NOTIFICATION OF JURISDICTIONAL DETERMINATION

Requestor:	**Water & Land Solutions, LLC**
	Mr. Kyle Obermiller
Address:	**7721 Six Forks Road, Suite 130**
	Raleigh, North Carolina 27615
Telephone Number:	**828-808-2240**
E-mail:	**kyle@waterlandsolutions.com**

Size (acres)	**20.1**	Nearest Town	**Deep Run**
Nearest Waterway	**Southwest Creek**	River Basin	**Neuse**
USGS HUC	**03020202**	Coordinates	Latitude: **35.133519**
			Longitude: **-77.655106**

Location description: **The project area is located north of the property at 662 P A Nobles Store Road, Deep Run, NC. Parcel Index Numbers: 450000157485; 450000570958; 450000168662; 450000179525; 450000362113.**

Indicate Which of the Following Apply:

A. Preliminary Determination

☒ There appear to be **waters, including wetlands** on the above described project area/property, that may be subject to Section 404 of the Clean Water Act (CWA)(33 USC § 1344) and/or Section 10 of the Rivers and Harbors Act (RHA) (33 USC § 403). The **waters, including wetlands** have been delineated, and the delineation has been verified by the Corps to be sufficiently accurate and reliable. The approximate boundaries of these waters are shown on the enclosed delineation map dated **2/7/2020**. Therefore this preliminary jurisdiction determination may be used in the permit evaluation process, including determining compensatory mitigation. For purposes of computation of impacts, compensatory mitigation requirements, and other resource protection measures, a permit decision made on the basis of a preliminary JD will treat all waters and wetlands that would be affected in any way by the permitted activity on the site as if they are jurisdictional waters of the U.S. This preliminary determination is not an appealable action under the Regulatory Program Administrative Appeal Process (Reference 33 CFR Part 331). However, you may request an approved JD, which is an appealable action, by contacting the Corps district for further instruction.

☐ There appear to be **waters, including wetlands** on the above described project area/property, that may be subject to Section 404 of the Clean Water Act (CWA)(33 USC § 1344) and/or Section 10 of the Rivers and Harbors Act (RHA) (33 USC § 403). However, since the **waters, including wetlands** have not been properly delineated, this preliminary jurisdiction determination may not be used in the permit evaluation process. Without a verified wetland delineation, this preliminary determination is merely an effective presumption of CWA/RHA jurisdiction over all of the **waters, including wetlands** at the project area, which is not sufficiently accurate and reliable to support an enforceable permit decision. We recommend that you have the **waters, including wetlands** on your project area/property delineated. As the Corps may not be able to accomplish this wetland delineation in a timely manner, you may wish to obtain a consultant to conduct a delineation that can be verified by the Corps.

B. Approved Determination

☐ There are Navigable Waters of the United States within the above described project area/property subject to the permit requirements of Section 10 of the Rivers and Harbors Act (RHA) (33 USC § 403) and Section 404 of the Clean Water Act (CWA)(33 USC § 1344). Unless there is a change in law or our published regulations, this determination may be relied upon for a period not to exceed five years from the date of this notification.

☐ There are **waters, including wetlands**on the above described project area/property subject to the permit requirements of Section 404 of the Clean Water Act (CWA) (33 USC § 1344). Unless there is a change in the law or our published regulations, this determination may be relied upon for a period not to exceed five years from the date of this notification.

☐ We recommend you have the **waters, including wetlands** on your project area/property delineated. As the Corps may not be able to accomplish this wetland delineation in a timely manner, you may wish to obtain a consultant to conduct a delineation that can be verified by the Corps.

☐ The **waters, including wetlands** on your project area/property have been delineated and the delineation has been verified by the Corps. The approximate boundaries of these waters are shown on the enclosed delineation map dated **DATE**. We strongly suggest you have this delineation surveyed. Upon completion, this survey should be reviewed and verified by the Corps. Once verified, this survey will provide an accurate depiction of all areas subject to CWA jurisdiction on your property which, provided there is no change in the law or our published regulations, may be relied upon for a period not to exceed five years.

☐ The **waters, including wetlands** have been delineated and surveyed and are accurately depicted on the plat signed by the Corps Regulatory Official identified below on**DATE**. Unless there is a change in the law or our published regulations, this determination may be relied upon for a period not to exceed five years from the date of this notification.

☐ There are no waters of the U.S., to include wetlands, present on the above described project area/property which are subject to the permit requirements of Section 404 of the Clean Water Act (33 USC 1344). Unless there is a change in the law or our published regulations, this determination may be relied upon for a period not to exceed five years from the date of this notification.

☐ The property is located in one of the 20 Coastal Counties subject to regulation under the Coastal Area Management Act (CAMA). You should contact the Division of Coastal Management in **Morehead City, NC, at (252) 808-2808** to determine their requirements.

Placement of dredged or fill material within waters of the US, including wetlands, without a Department of the Army permit may constitute a violation of Section 301 of the Clean Water Act (33 USC § 1311). Placement of dredged or fill material, construction or placement of structures, or work within navigable waters of the United States without a Department of the Army permit may constitute a violation of Sections 9 and/or 10 of the Rivers and Harbors Act (33 USC § 401 and/or 403). If you have any questions regarding this determination and/or the Corps regulatory program, please contact **Emily B. Thompson at (910)251-4629 or Emily.B.Thompson@usace.army.mil**.

C. Basis For Determination: The wetlands within the project area were delineated using the Corps of Engineers 1987 Wetland Delineation Manual and the Atlantic and Gulf Coastal Plain Regional Supplement Version 2.0.

D. Remarks: None.

E. Attention USDA Program Participants

This delineation/determination has been conducted to identify the limits of Corps' Clean Water Act jurisdiction for the particular site identified in this request. The delineation/determination may not be valid for the wetland conservation provisions of the Food Security Act of 1985. If you or your tenant are USDA Program participants, or anticipate participation in USDA programs, you should request a certified wetland determination from the local office of the Natural Resources Conservation Service, prior to starting work.

F. Appeals Information (This information applies only to approved jurisdictional determinations as indicated in B. above)

This correspondence constitutes an approved jurisdictional determination for the above described site. If you object to this determination, you may request an administrative appeal under Corps regulations at 33 CFR Part 331. Enclosed you will find a Notification of Appeal Process (NAP) fact sheet and request for appeal (RFA) form. If you request to appeal this determination you must submit a completed RFA form to the following address:

US Army Corps of Engineers
South Atlantic Division
Attn: Phillip Shannin, Review Officer
60 Forsyth Street SW, Room 10M15
Atlanta, Georgia 30303-8801

In order for an RFA to be accepted by the Corps, the Corps must determine that it is complete, that it meets the criteria for appeal under 33 CFR part 331.5, and that it has been received by the Division Office within 60 days of the date of the NAP. Should you decide to submit an RFA form, it must be received at the above address by **Not applicable**.

It is not necessary to submit an RFA form to the Division Office if you do not object to the determination in this correspondence.

Corps Regulatory Official: Emily B. Thompson

Date of JD: **3/27/2020** Expiration Date of JD: **Not applicable**

SAW-2018-01762
The Wilmington District is committed to providing the highest level of support to the public. To help us ensure we continue to do so, please complete the Customer Satisfaction Survey located at http://corpsmapu.usace.army.mil/cm_apex/f?p=136:4:0

Copies furnished (via email):

Property Owners via authorized agent

USACE: **Kim Browning**
Email: **Kimberly.D.Browning@usace.army.mil**

NOTIFICATION OF ADMINISTRATIVE APPEAL OPTIONS AND PROCESS AND REQUEST FOR APPEAL		
Applicant: **Water & Land Solutions, LLC**, **Mr. Kyle Obermiller**	File Number: **SAW-2018-01762**	Date: **03/23/2020**

Attached is:	See Section below
☐ INITIAL PROFFERED PERMIT (Standard Permit or Letter of permission)	A
☐ PROFFERED PERMIT (Standard Permit or Letter of permission)	B
☐ PERMIT DENIAL	C
☐ APPROVED JURISDICTIONAL DETERMINATION	D
☒ PRELIMINARY JURISDICTIONAL DETERMINATION	E

SECTION I - The following identifies your rights and options regarding an administrative appeal of the above decision. Additional information may be found at or http://www.usace.army.mil/Missions/CivilWorks/RegulatoryProgramandPermits.aspx or the Corps regulations at 33 CFR Part 331.

A: INITIAL PROFFERED PERMIT: You may accept or object to the permit.

- ACCEPT: If you received a Standard Permit, you may sign the permit document and return it to the district engineer for final authorization. If you received a Letter of Permission (LOP), you may accept the LOP and your work is authorized. Your signature on the Standard Permit or acceptance of the LOP means that you accept the permit in its entirety, and waive all rights to appeal the permit, including its terms and conditions, and approved jurisdictional determinations associated with the permit.
- OBJECT: If you object to the permit (Standard or LOP) because of certain terms and conditions therein, you may request that the permit be modified accordingly. You must complete Section II of this form and return the form to the district engineer. Your objections must be received by the district engineer within 60 days of the date of this notice, or you will forfeit your right to appeal the permit in the future. Upon receipt of your letter, the district engineer will evaluate your objections and may: (a) modify the permit to address all of your concerns, (b) modify the permit to address some of your objections, or (c) not modify the permit having determined that the permit should be issued as previously written. After evaluating your objections, the district engineer will send you a proffered permit for your reconsideration, as indicated in Section B below.

B: PROFFERED PERMIT: You may accept or appeal the permit

- ACCEPT: If you received a Standard Permit, you may sign the permit document and return it to the district engineer for final authorization. If you received a Letter of Permission (LOP), you may accept the LOP and your work is authorized. Your signature on the Standard Permit or acceptance of the LOP means that you accept the permit in its entirety, and waive all rights to appeal the permit, including its terms and conditions, and approved jurisdictional determinations associated with the permit.
- APPEAL: If you choose to decline the proffered permit (Standard or LOP) because of certain terms and conditions therein, you may appeal the declined permit under the Corps of Engineers Administrative Appeal Process by completing Section II of this form and sending the form to the division engineer. This form must be received by the division engineer within 60 days of the date of this notice.

C: PERMIT DENIAL: You may appeal the denial of a permit under the Corps of Engineers Administrative Appeal Process by completing Section II of this form and sending the form to the division engineer. This form must be received by the division engineer within 60 days of the date of this notice.

D: APPROVED JURISDICTIONAL DETERMINATION: You may accept or appeal the approved JD or provide new information.

- ACCEPT: You do not need to notify the Corps to accept an approved JD. Failure to notify the Corps within 60 days of the date of this notice, means that you accept the approved JD in its entirety, and waive all rights to appeal the approved JD.
- APPEAL: If you disagree with the approved JD, you may appeal the approved JD under the Corps of Engineers Administrative Appeal Process by completing Section II of this form and sending the form to the district engineer. This form must be received by the division engineer within 60 days of the date of this notice.

E: PRELIMINARY JURISDICTIONAL DETERMINATION: You do not need to respond to the Corps regarding the preliminary JD. The Preliminary JD is not appealable. If you wish, you may request an approved JD (which may be appealed), by contacting the Corps district for further instruction. Also you may provide new information for further consideration by the Corps to reevaluate the JD.

SECTION II - REQUEST FOR APPEAL or OBJECTIONS TO AN INITIAL PROFFERED PERMIT

REASONS FOR APPEAL OR OBJECTIONS: (Describe your reasons for appealing the decision or your objections to an initial proffered permit in clear concise statements. You may attach additional information to this form to clarify where your reasons or objections are addressed in the administrative record.)

ADDITIONAL INFORMATION: The appeal is limited to a review of the administrative record, the Corps memorandum for the record of the appeal conference or meeting, and any supplemental information that the review officer has determined is needed to clarify the administrative record. Neither the appellant nor the Corps may add new information or analyses to the record. However, you may provide additional information to clarify the location of information that is already in the administrative record.

POINT OF CONTACT FOR QUESTIONS OR INFORMATION:

If you have questions regarding this decision and/or the appeal process you may contact: **District Engineer, Wilmington Regulatory Division** **Attn: Emily B. Thompson** **Washington Regulatory Office** **U.S Army Corps of Engineers** **2407 West Fifth Street** **Washington, North Carolina 27889**	If you only have questions regarding the appeal process you may also contact: Mr. Phillip Shannin, Administrative Appeal Review Officer CESAD-PDO U.S. Army Corps of Engineers, South Atlantic Division 60 Forsyth Street, Room 10M15 Atlanta, Georgia 30303-8801 Phone: (404) 562-5137

RIGHT OF ENTRY: Your signature below grants the right of entry to Corps of Engineers personnel, and any government consultants, to conduct investigations of the project site during the course of the appeal process. You will be provided a 15 day notice of any site investigation, and will have the opportunity to participate in all site investigations.

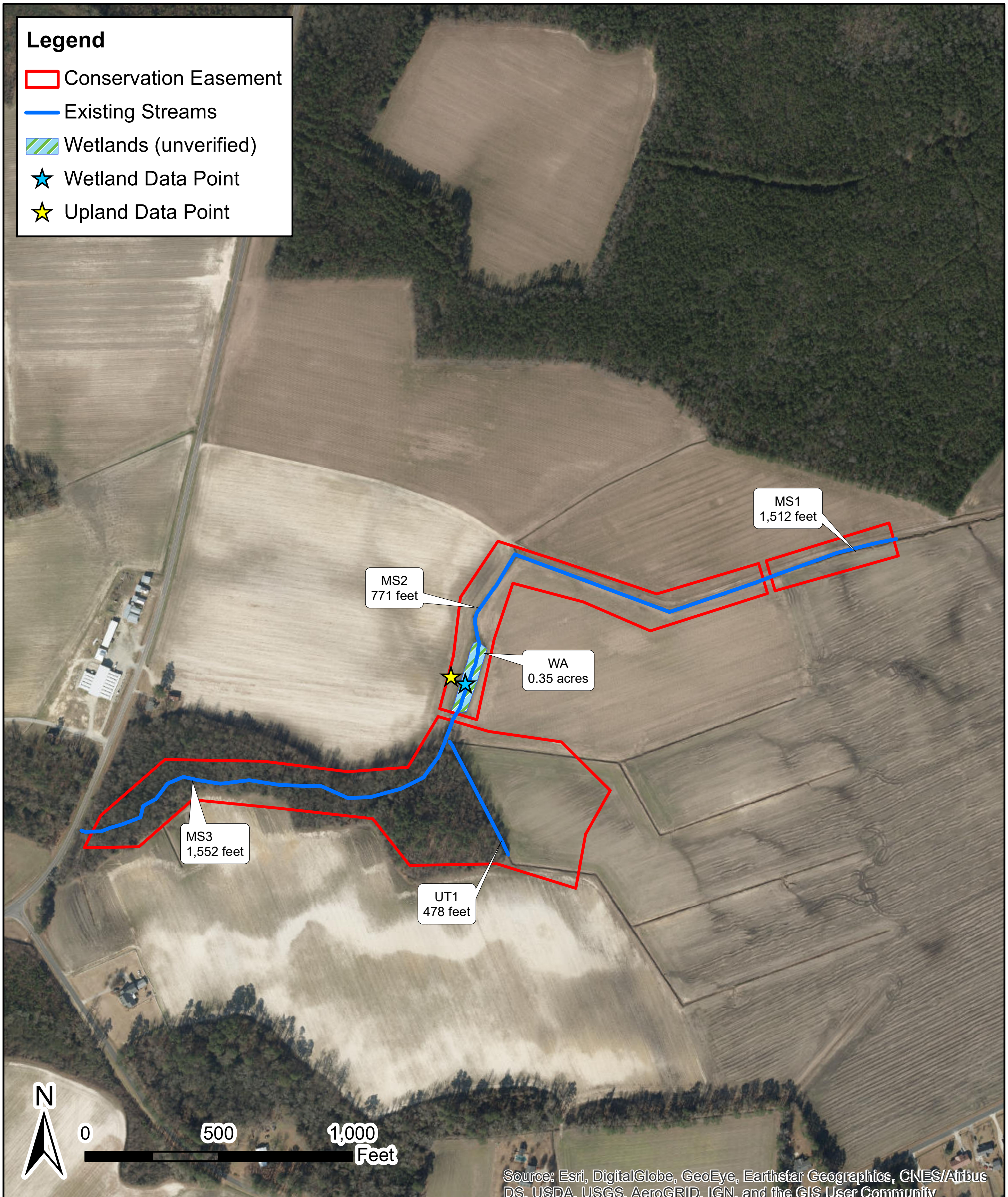
___________________________________ Signature of appellant or agent.	Date:	Telephone number:

For appeals on Initial Proffered Permits send this form to:

District Engineer, Wilmington Regulatory Division, **Attn: Emily B. Thompson, 69 Darlington Avenue, Wilmington, North Carolina 28403**

For Permit denials, Proffered Permits and Approved Jurisdictional Determinations send this form to:

Division Engineer, Commander, U.S. Army Engineer Division, South Atlantic, Attn: Mr. Phillip Shannin, Administrative Appeal Officer, CESAD-PDO, 60 Forsyth Street, Room 10M15, Atlanta, Georgia 30303-8801
Phone: (404) 562-5137



WATER & LAND™ SOLUTIONS

Hornpipe Branch Tributaries Mitigation Project

Revised map received 2-7-2020 EBT

Existing Hydrography

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE 4

Appendix 10 – Invasive Species Plan

WLS will treat invasive species vegetation within the project area and provide remedial action on a case by-case basis. Common invasive species vegetation, such as Chinese privet (*Ligustrum sinense*) and multiflora rose (*Rosa multiflora*), will be removed to allow native plants to become established within the conservation easement. Invasive species vegetation will be treated by approved mechanical and/or chemical methods such that the percent composition of exotic/invasive species vegetation is less than 5% of the total riparian buffer area. Any control methods requiring herbicide application will be performed in accordance with NC Department of Agriculture (NCDA) rules and regulations. If necessary, these removal treatments (i.e., cutting and/or spraying) will continue until the corrective actions demonstrate that the site is trending towards or meeting the standard monitoring requirement.

Appendix 11 – Approved FHWA Categorical Exclusion Form

Appendix A

Categorical Exclusion Form for Ecosystem Enhancement Program Projects
Version 1.4

Note: Only Appendix A should to be submitted (along with any supporting documentation) as the environmental document.

Part 1: General Project Information	
Project Name:	Hornpipe Branch Tributaries Mitigation Project
County Name:	Lenoir
EEP Number:	DMS Proj. #100076, DMS Contract #7605
Project Sponsor:	Water & Land Solutions, LLC
Project Contact Name:	William "Scott" Hunt, III, PE
Project Contact Address:	10940 Raven Ridge Road, Ste. 200, Raleigh, NC 27614
Project Contact E-mail:	scott@waterlandsolutions.com
EEP Project Manager:	Lindsay Crocker

Project Description

The Hornpipe Branch Tributaries Mitigation Project is a full-delivery project for the NCDEQ Division of Mitigation Services (DMS) identified and contracted to provide stream mitigation credits for permitted, unavoidable impacts in the Neuse River Basin, Cataloging Unit 03020202. The project will involve the restoration, and permanent protection of five stream reaches (Reaches UT1, UT2, MS1, MS2 and MS3), totaling approximately 5,400 linear feet of existing streams. In addition, the adjacent riparian wetlands and riparian buffers will be restored and the entire restored corridor will be protected by a permanent conservation easement, approximately 23 acres in size, to be held by the State of North Carolina. The project site consists of a degraded headwater stream and riparian wetland system that flows through a riparian corridor between active agricultural fields and then into Southwest Creek, which eventually drains to the Neuse River. The proposed restoration project not only has the potential to provide at least 5,000 stream mitigation credits, but will also provide significant ecological improvements and functional uplift through habitat restoration, and through decreasing nutrient and sediment loads from the project watershed.

For Official Use Only

Reviewed By:

10/10/2018 — JHCrocker

Date — **EEP Project Manager**

Conditional Approved By:

Date — **For Division Administrator FHWA**

☐ **Check this box if there are outstanding issues**

Final Approval By:

10-10-18

Date — **For Division Administrator FHWA**

Appendix 12 – Agency Correspondence & Floodplain Checklist

WATER & LAND SOLUTIONS

Meeting Minutes

Neuse 03020202 DMS Full-Delivery Project:

Hornpipe Branch Tributaries Mitigation Project
(DMS Contract #7605, Proj. ID# 100076)

Subject: NCIRT Post-Contract Site Meeting

Date Prepared: September 4, 2018

Meeting Date and Time: August 22, 2018 @ 1130

Meeting Location: On-site (Lenoir County, NC)

Recorded By: Kayne VanStell and Scott Hunt

Attendees: USACE: Todd Tugwell (NCIRT)

NCDEQ DWR: Mac Haupt (NCIRT)

NCDEQ DMS: Jeff Schaffer and Lindsay Crocker

NCWRC: Travis Wilson (NCIRT)

WLS: Kayne VanStell and Scott Hunt

LDSI: Jonathan Hinkle

These meeting minutes document notes and discussion points from the North Carolina Interagency Review Team (NCIRT) Post-Contract Site Meeting for the Hornpipe Branch Tributaries Mitigation Project (Neuse River Basin, CU 03020202). This full-delivery project was contracted on June 15, 2018, by the North Carolina Department of Environmental Quality (NCDEQ), Division of Mitigation Services (DMS), with Water & Land Solutions, LLC (WLS), under RFP 16-007401. The project site is located in Lenoir County, near Deep Run, North Carolina.

The Hornpipe Branch Tributaries Mitigation Project (project) Post-Contract Site Meeting began on-site at approximately 1130. Scott opened meeting with introductions, a project description, and a general summary of the overall project concepts. After the project introduction and overview, attendees toured the project site to review existing conditions and proposed mitigation types, strategies, and design concepts. The attendees started the reach walks at the upstream end of the project, MS1, traversed downstream along MS1 to MS2, walked along UT2, and then downstream to MS3. The project site review notes are presented below in the order they were visited.

During the project introduction, before walking the project reaches, NCIRT expressed some concern about the coordination and connection between the potential future mitigation bank and the contracted full-delivery project. The NCIRT emphasized establishing a clear division between the full-delivery and future mitigation bank project with regards to these concerns.

1. MS1: The attendees started at the upstream end of the project at MS1 and walked downstream. At the upstream end of MS1, Todd initially expressed concern regarding the affects that raising streambed will have on the farm hydrology and agricultural production. Jonathan, whose father-in-law, Randy Smith, is one of the property owners that manages the farm. He explained that Randy's operation is moving away from tobacco, which is what the historic/current drainage system and infrastructure was set up to support and produce. Jonathan further explained that Randy is moving towards grain crop production and therefore raising the bed of stream and water table will have a positive effect for crop access and production purposes. The drainage area for MS1 was noted as 186 acres, just upstream of the break between MS1 and MS2 confluence. Mac noted, during discussions about smaller drainage areas, that he concurred with a headwater valley restoration approach versus proposing a single thread channel in the upper reach. Mac explained that he was basing his comment on drainage area and referred to the Johnston Soil Series, which are considered fluvial soils, and are mapped in some of the project valleys.

2. MS2: Near the beginning of MS2, Travis noted concerns about how deep the existing channel is and expressed concern about WLS being able to successfully plug and fill the existing channel without losing water to sub-surface flow. Kayne explained that we have successfully implemented the strategy and practice of plugging the existing channel by harvesting suitable/compactable fill material in this type of setting. The group also discussed the existing farm path will need to be relocated, specifically IRT had concerns regarding historic compaction and the logistics involved with relocating the roadbed in some locations.

3. UT2: The group stopped for discussion at the downstream end of UT2. Todd walked to top of the reach to observe flow and headwater conditions. Mac suggested installing a surface flow gauge about halfway down (not at top, not at bottom) the reach, which he explained is the standard requirement at this time to address jurisdictional flow requirements. Mac also noted that the requirement of 30 days of flow is still current standard, to which Travis agreed as well. Mac further explained that 30 consecutive days may not be enough flow duration when headwater systems are restored as single thread channels, at the location he believes are at the ephemeral/intermittent breaks.

4. UT1: The group did not walk entire UT1 and continued walking into the woods near the top of MS3.

5. MS3: The NCIRT agreed with the stream restoration approach proposed for this reach after observing the existing conditions. The NCIRT asked about existing condition of MS3 further downstream. Kayne and Scott explained that channel condition/ incision deepens further down the reach until transitioning back down into the road culvert at the end of the project. Kayne and Scott further

explained that the bank heights lower slightly along the last hundred feet at the downstream end of MS3, allowing for a more gradual transition to the NCDOT culvert at the project terminus. The NCIRT asked if Priority Level II restoration was necessary or abrupt step structures are proposed for the transition at the downstream end of the reach. Kayne explained that we typically do not propose that type of design and prefer a more gradual/natural slope transition. Travis and Todd agreed with idea of stopping the downstream project limit/easement boundary before the NCDOT right-of-way (approx. 40 feet) to allow for future NCDOT culvert replacement, maintenance, etc. Todd asked about proposed sinuosity noting that the valley seemed relatively narrow and confined for this region. Kayne explained we would likely use lower/conservative sinuosity that is appropriate for the valley setting, in order to save significant trees and work within the site constraints.

6. Although no wetland mitigation credits are proposed or contracted, Todd recommended the installation of groundwater wells to monitor groundwater recharge along the floodplain and to monitor rehydration of soils for informational and functional uplift documentation purposes. Todd also stressed the importance of conducting the jurisdictional determinations (JDs) in order to help develop the proposed design approach with regards to minimizing impacts to existing wetlands.

7. At approximately 1:30 PM, Travis and Todd had to leave the site. The remaining attendees visited one of the local reference reaches, located in the adjacent drainage immediately to the north of the project, owned by the project property owners. This reference reach has a similar drainage area and valley slope as UT1 (approximately 30 acres and 0.005 ft/ft) and is a moderately defined stream system that exhibits perennial surface flow. The group focused mainly at the upstream end of this reference reach. Mac expressed his support to use this headwater system as a project reference reach and a desire for the NCIRT to consider the reach for broader inclusion into the coastal plain headwater reference stream study data set. The group walked downstream along several sections of the reference reach and concluded the meeting.

Concluding Comments

The above minutes represents Water & Land Solutions' interpretation and understanding of the meeting discussion and actions. If recipients of these minutes should find any information contained in these minutes to be in error, incomplete, please notify the author with appropriate corrections and/or additions within five (5) business days to allow adequate time for correction and redistribution.

EEP Floodplain Requirements Checklist

This form was developed by the National Flood Insurance program, NC Floodplain Mapping program and Ecosystem Enhancement Program to be filled for all EEP projects. The form is intended to summarize the floodplain requirements during the design phase of the projects. The form should be submitted to the Local Floodplain Administrator with three copies submitted to NFIP (attn. State NFIP Engineer), NC Floodplain Mapping Unit (attn. State NFIP Coordinator) and NC Ecosystem Enhancement Program.

Project Location

Name of project:	Hornpipe Branch Tributaries Mitigation Project
Name if stream or feature:	Unnamed tributaries to Hornpipe Branch
County:	Lenoir
Name of river basin:	Neuse
Is project urban or rural?	Rural
Name of Jurisdictional municipality/county:	Lenoir County
DFIRM panel number for entire site:	4500 of 4660 (map number 3720450000K, effective date 4/16/2013)
Consultant name:	Water & Land Solutions, LLC
Phone number:	919-614-5111
Address:	7721 Six Forks Road, Suite 130 Raleigh, NC 27615

Design Information

The Hornpipe Branch Tributaries Mitigation Project (Project) is located within a rural watershed in Lenoir County, within the Neuse River Basin and USGS 14-digit HUC 03020202050010. The Project proposes to restore and protect approximately 5,160 linear feet of stream and provide a water quality benefit for a 331 acre drainage area. The stream mitigation components are summarized in the table below. The purpose of the Project is to meet water quality improvements described in the Neuse River Basin Restoration Priorities and improve overall aquatic resource health.

Reach Name	Length (feet)	Mitigation Type
MS1	1,449	Stream Restoration (PI/PII)
MS2	943	Stream Restoration (PI)
MS3	1,529	Stream Restoration (PI)
UT1	677	Stream Restoration (PI/HW)
UT2	562	Stream Restoration (PI/HW)

Floodplain Information

Is project located in a Special Flood Hazard Area (SFHA)?

○ Yes ◉ No

If project is located in a SFHA, check how it was determined:

☐ Redelineation

☐ Detailed Study

☐ Limited Detail Study

☐ Approximate Study

☐ Don't know

List flood zone designation: Zone X Minimal Flood Risk

Check if applies:

☐ AE Zone

○ Floodway

○ Non-Encroachment

◉ None

☐ A Zone

○ Local Setbacks Required

○ No Local Setbacks Required
If local setbacks are required, list how many feet:
Does proposed channel boundary encroach outside floodway/non-encroachment/setbacks? ○ Yes ● No
Land Acquisition (Check) ☐ State owned (fee simple) ☐ Conservation easment (Design Bid Build) ☑ Conservation Easement (Full Delivery Project) Note: if the project property is state-owned, then all requirements should be addressed to the Department of Administration, State Construction Office (attn: Herbert Neily, (919) 807-4101)
Is community/county participating in the NFIP program? ○ Yes ● No Note: if community is not participating, then all requirements should be addressed to NFIP (attn: State NFIP Engineer, 919-715-8000
Name of Local Floodplain Administrator: Lenoir County Planning, Jenny Wheelock Phone Number: 828-757-2168

Floodplain Requirements

This section to be filled by designer/applicant following verification with the LFPA

☑ No Action

☐ No Rise

☐ Letter of Map Revision

☐ Conditional Letter of Map Revision (CLOMR)

☐ Other Requirements

List other requirements: N/a

Comments: Project is not in a FEMA zone

Name: KAYNE VANSTELL Signature: Kayne VanStell

Title: VP, ECOSYSTEM DESIGN Date: 1.28.20

35°10'42.56"N

77°39'35.85"W

USGS The National Map: Orthoimagery. Data refreshed April, 2019.

77°35'48.88"W

35°6'30.92"N

FLOOD HAZARD INFORMATION

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS	Without Base Flood Elevation (BFE) *Zone A, V, A99* With BFE or Depth *Zone AE, AO, AH, VE, AR* Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD	0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X* Future Conditions 1% Annual Chance Flood Hazard *Zone X* Area with Reduced Flood Risk due to Levee See Notes. *Zone X* Area with Flood Risk due to Levee *Zone D*
OTHER AREAS	NO SCREEN Area of Minimal Flood Hazard *Zone X* Effective LOMRs Area of Undetermined Flood Hazard *Zone D*
GENERAL STRUCTURES	Channel, Culvert, or Storm Sewer Levee, Dike, or Floodwall
OTHER FEATURES	B 20.2 Cross Sections with 1% Annual Chance 17.5 Water Surface Elevation 8 Coastal Transect Coastal Transect Baseline Profile Baseline Hydrographic Feature 513 Base Flood Elevation Line (BFE) Limit of Study Jurisdiction Boundary

NOTES TO USERS

For information and questions about this Flood Insurance Rate Map (FIRM), available products associated with this FIRM, including historic versions, the current map date for each FIRM panel, how to order products, or the National Flood Insurance Program (NFIP) in general, please call the FEMA Map Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Flood Map Service Center website at http://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can beordered or obtained directly from the website.

Communities annexing land on adjacent FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM Index. These may be ordered directly from the Flood Map Service Center at the number listed above.

For community and countywide map dates refer to the Flood Insurance Study Report for this jurisdiction.

To determine if flood insurance is available in this community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

Basemap information shown on this FIRM was provided in digital format by USDA, Farm Service Agency (FSA). This information was derived from NAIP, dated April 11, 2018.

This map was exported from FEMA's National Flood Hazard Layer (NFHL) on **12/31/2019 3:56:17 PM** and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time. For additional information, please see the Flood Hazard Mapping Updates Overview Fact Sheet at https://www.fema.gov/media-library/assets/documents/118418

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date.

SCALE

N

Map Projection:
GCS, Geodetic Reference System 1980;
Vertical Datum: NAVD88
For information about the specific vertical datum for elevation features, datum conversions, or vertical monuments used to create this map please see the Flood Insurance Study(FIS) Report for your community at https://msc.fema.gov

1 inch = 1,000 feet 1:12,000

0 500 1,000 2,000 3,000 4,000 Feet

Meters
0 105 210 420 630 840

FEMA

National Flood Insurance Program

NATIONAL FLOOD INSURANCE PROGRAM

FLOOD INSURANCE RATE MAP

LENOIR COUNTY, NORTH CAROLINA AND INCORPORATED AREAS

PANEL **4500** OF **4660**

Panel Contains:

COMMUNITY	NUMBER	PANEL
LENOIR COUNTY NORTH CAROLINA	370144	4500

MAP NUMBER
3720450000K
EFFECTIVE DATE
04/16/2013